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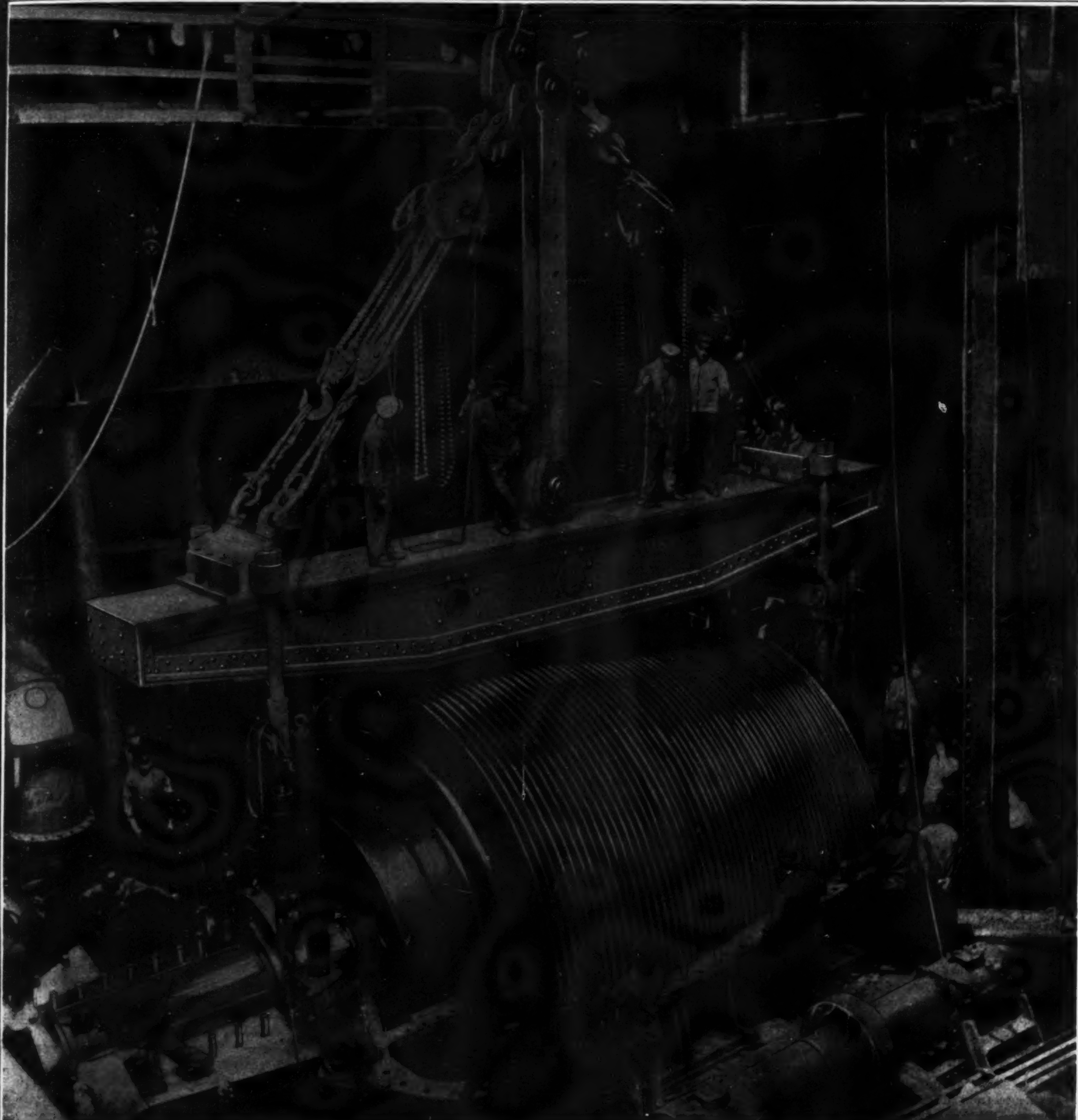

THE STEAMSHIP "VATERLAND'S" ENGINES

The machinery of the steamship "Vaterland," the largest ship in the world, is the most powerful ever installed on shipboard. The liner is propelled by four enormous screws driven by great turbines. In the accompanying illustration one of the forward rotors of the "Vaterland" is shown being lowered into position. The group of workmen surrounding it is completely dwarfed by the rotor, which measures 17½ feet in length and 17 feet in diameter. The "Vaterland" is a sister ship of the famous "Imperator," but surpasses her in every dimension, measuring 950 feet in length, 100 feet in beam, and has 58,000 tons burden. The "Imperator," with a length of 919 feet, a beam of 98 feet, and a tonnage of 52,000, is, in turn, 5,000 tons larger than any other ship afloat. A third ship is now building.

The Chances of Death and the Ministry of Health*

Some Lessons Taught by Vital Statistics

By Frederick L. Hoffman, LL.D.

The scientific study of death is called thanatology, and, as said by the late Roswell Park, who coined the term, it is a much neglected subject. The best modern treatise on the subject is by Charles S. Minot, published under the title "The Problem of Age, Growth, and Death," in the Science Series of 1908. This is a study of cytomorphosis, or the conception that death is a function of age in its relation to the cellular changes of the body. Just as no one has as yet succeeded in providing an entirely satisfactory definition of life, so also there is no concise description or brief generalization of the terms "death" and "disease." We are not able to give an answer to the question as to how life originated, and it is quite probable that the riddles of life and death will prove continuous with the duration of human existence on the earth.

The conception of death in modern life as a matter of pure chance has no doubt lost much of its earlier significance. The abject terror and the blind acquiescence common to periods of history when epidemic diseases destroyed vast numbers of lives within an incredibly short period of time have given way to an increasing faith and certainty in the prolongation of human existence and the normal attainment of at least the Scriptural period of threescore years and ten. It is quite difficult for the modern mind to visualize effectively the terrible experiences passed through by the people of this country in the last years of the eighteenth century, when yellow fever prevailed as far north as Boston, New York, and Philadelphia, or even in the middle of the nineteenth century, when the same dread disease devastated time and again the larger cities of the lower South. Cholera prevailed to the extent of an alarming epidemic in the city of New York in 1849, and as late as 1905 yellow fever paralyzed the commerce of the South and brought sorrow and grief to the homes of many, from the throne of an archbishop to the hovel of the poor. It would serve no purpose to review on this occasion the sanitary history of the nation or to comment on the frightful waste of human life incident to the epidemics which in the past have devastated this land, hindered its material progress, and brought sorrow and affliction to the homes of helpless millions. Nor would it serve much of a purpose to recall the history of the Black Death of the fourteenth century, which, in all probability, was the most deadly pestilence in the history of mankind. Rather than, in the words of Hecker, the historian of the Black Death, "That Omnipotence, which has called the world with all its living creatures into one animated being, especially reveals Himself in the desolation of great pestilences," is it true to-day that such lamentations and destructive occurrences reveal human ignorance and human indifference, in contrast to realized intelligence and sanitary control. Rather than it being true, again in the words of Hecker, that "Nature is not satisfied with the ordinary alterations of life and death," and that pestilence and plague are revolutions "performed in vast cycles, which the spirit of man, limited, as it is, to a narrow circle of perception, is unable to explore," is the modern and incontrovertible fact that these recurrences, so characteristic of the past history of mankind, can be and are made impossible by a more rational mode of life, considered individually, and in the aggregate subject to intelligent acquiescence in the established truth of sanitary science and sanitary control.

We are no longer seriously concerned with the possible risk of nation-wide epidemics, which are effectively guarded against by a national health service protecting the people against the introduction of plague and pestilence from abroad. Modern preventive medicine concerns itself chiefly with the spread of less destructive transmissible diseases, which still in the aggregate, however, cause a lamentable and largely needless loss of human life. The hygiene of transmissible diseases, their causation, modes of dissemination, and methods of prevention, constitutes a branch of science than which none has yielded results of greater benefit to mankind. Either the causation of such diseases or the mode of their spread from one person to another is now reasonably well understood, and the factors of transmission are controlled to a degree which falls little short of the miraculous. Most of the so-called preventable diseases are diminishing in frequency in civilized countries, chiefly smallpox, typhoid fever, tuberculosis, diphtheria, measles, scarlet fever, whooping cough, malarial fever, etc. Some of these diseases are controlled by vaccination or protective inoculation, as best illustrated in the marvelous results of typhoid fever prophylaxis in the United States Army, by means of which the rate of frequency occurrence has been brought practically to a negligible quantity. Many of these diseases, however, are so widely diffused, and they are so complex in their relation to the human environment and the habits and customs of the human individual, that many years will pass before the death rate will be strictly normal, and one, on being born, will have a fair chance of attaining the maximum duration of life. But the future outlook for life extension is most encouraging, and there can be no question of doubt but that during the next generation a still further material reduction in the general death rate will be achieved.

THE HUMAN CONTROL AND THE DEATH RATE.

The discovery of a great truth serves no real purpose unless the new knowledge is realized in conduct and used in the solution of the problems of society. The realization of the ideal in health administration requires the intelligent, sympathetic, and effective co-operation of all the various interests affected. The burden of responsibility for a high death rate falls, not on the medical profession, but largely upon the public itself, since the problems of sanitary control are largely and fundamentally a matter of Government supervision and concern. The responsibility for life waste is one of inefficient citizenship, on the one hand, and of inefficient leadership and direction, on the other. The duty of direction and control is individual as well as social, and concerns the ministry of the spirit as much as it does the ministry of the body. But the truth has come like a startling revelation to intelligent mankind, that pestilence, and even the common diseases of human life, are largely because of gross neglect, gross indifference, filth, ignorance, and unwarrantable delay in heeding the earliest symptoms of maladjustment in the human economy or the need of repair in the human machine. Problems of life and health are, therefore, matters of most serious concern to the clergy as well as to the physician, to the teacher as well as to the sanitary officer, and, in fact, in no relation of life is the Biblical doctrine that we are all our brother's keeper more beautifully illustrated than in the chances of death and the ministry of health. Rigid conformity to the truth of the causation of tuberculosis, of the spread of diphtheria by personal infection, of the contraction of smallpox by neglect of vaccination, of deaths from yellow fever because of contempt for the stegomyia mosquito, all prove the infinite possibilities of realizing life's larger purposes by the intelligent prevention of its needless waste. Instruction of mothers in the hygiene of infancy will effectively aid in solving the question as to whether the child will live and grow in strength of body and mind, just as rigid conformity to established principles of safety will protect the lives of passengers on land and sea. It is largely a question, first, of knowledge, then, of understanding, and, finally, of unswerving fidelity to the principles of truth as applicable to human conduct for the purposes of human betterment.

THE INCREASE IN THE DURATION OF LIFE.

The present annual death rate of the United States is only 13.9 per 1,000, against a rate of 19.8 in 1880. The saving in years of life in consequence of a declining death rate is so enormous for a vast country like ours that the true meaning of statistical calculations can hardly be made intelligible to the average mind. Sooner or later everyone must die, but the question is one of how long, on the average, each life can be made to last, when a gulf greater than the Atlantic or the Pacific separates the people who in one section live to an average age of 45, and in another to 60. Life tables illustrate with scientific precision natural law as applied to the tenure of man's existence on earth, but what is called the law of mortality is rather a symbolic expression of the law which governs all collective phenomena in the order of logical sequence, without which human existence, and in fact all existence, would be chaos. A study of mortality problems reveals more accurately than many another branch of science the marvels of life in the aggregate as conditioned by the more or less perfect co-ordination of the units, whether merely physically considered, or also in the broader sense of the psychological, moral, and spiritual. The duration of life is determined by an almost infinite number of variants, and even the wisest fail in the attempt to comprehend the whole. The diseases which afflict mankind are numerous, but most of the waste of life is due to a comparatively small number of causes, chiefly, in our own country, tuberculosis of the lungs, accounting for 9.4 per cent of the whole; organic diseases of the heart, accounting for 10.3 per cent; acute nephritis and Bright's disease, accounting for 7.4 per cent; pneumonia, accounting for 6.1 per cent; and cancer, accounting for 5.6 per cent. These six causes alone are responsible for 38.8 per cent of the entire mortality. Other diseases, now largely under control, but intrinsically as serious a menace to community life as any of those mentioned, are typhoid fever, smallpox, measles, scarlet fever, whooping cough, diphtheria, etc. The typhoid death rate, which is typical of sanitary progress or neglect, has declined in American cities from an average of 51 per 100,000 of population during the decade ending with 1892 to 25, or just about one half, during the decade ending with 1912; but our typhoid fever rate is still excessive, and no cause of death perhaps illustrates better the lamentable amount of still existing municipal neglect. Tuberculosis, the foe of mankind for ages, has, during the last generation, been brought within the range of human control, with a fair prospect that within a measurable period of time its ravages will be reduced still more than has been the case in the recent past. The tuberculosis death rate of American cities during the decade ending with 1882 was 318 per 100,000 of population, but the rate during the last decade was only 182. Within more recent years the mortality from smallpox has been reduced from an average of 3.4 during the five years ending with 1905 to a rate of only 0.3, or about one tenth of the earlier rate, during the year 1912. The mortality from the dread diseases of infancy, diphtheria and croup, has been reduced from an average of 29.6 during the five years ending with 1905 to 18.2 during the year 1912. We have no deaths from Asiatic cholera, nor from plague, except at quarantine stations subject to Federal control; either they are isolated or their introduction into this country is practically made impossible by means of a national health administration which challenges the admiration of the world. Yellow fever is no longer the foe of Southern States, and we have had practically no deaths from the disease since 1905. Of leprosy we have a few cases annually, but excepting the well-known leper settlements in Louisiana, there is slight danger to the country of a recrudescence of this perhaps most awful affliction of mankind.

NEW PROBLEMS OF PUBLIC HEALTH.

But with the passing or control of the diseases which have become common knowledge, new ailments and afflictions cause new problems of serious importance, because the conditions of spread are either entirely unknown or but imperfectly understood. Influenza is one of these diseases, which, within recent years, appeared for the first time as a national scourge in 1891, causing, directly or indirectly, an enormous loss of life, and the disease has since prevailed to a more or less extent, either as an immediate cause of death by itself, or as a cause or condition complicating other diseases. Pellagra may be mentioned in this connection as one of the new diseases in this country, the nature and treatment of which are as yet rather doubtful, but the combined efforts of the Federal and State governments, aside from the aroused interest of the medical profession, are at work to determine the methods of control. The word "control," perhaps better than the word "prevention," gives expression to the human effort in the struggle of mankind against disease and early death. No affliction of mankind to-day demands more serious consideration as a world menace than cancer, which has been increasing in practically every civilized country, and in the United States approximately at the rate of 25 per cent during the last decade. Cancer, or malignant disease, is one of the most mysterious afflictions, and it is doubtful whether it will ever be traced to a single cause; it is more likely that it has its origin in a combination of causes and conditioning circumstances largely beyond the penetrating intelligence aided by the most powerful instruments of research. The present solution of the cancer problem is largely one of early diagnosis and the earliest possible surgical treatment, just as in fire-fighting the problem of conflagration prevention is one of efficient apparatus, almost instantaneous notification and prompt response to established needs.

* Address delivered before the Divinity School, Yale University, New Haven, Conn., March 30th, 1914.

MURDER AND SELF-MURDER.

The problems of life, disease, and death are endless. The duty of applied intelligence in dealing with questions of preventable life loss and preventable disease is now so obvious on the part of every citizen, and most of all on the part of the leaders of community life in matters material, moral, intellectual, or spiritual, that it seems hardly necessary to refer to the profoundly sorrowful phase of human existence which leads to murder or self-murder, to insanity and degeneracy, or the deliberate impairment, by wrongful conduct, of the physical and mental faculties, with resulting pathological consequences and early death, or decrepit old age. The suicide rate of American cities has increased from an average of not quite 13 per 100,000 of population during the decade ending with 1892 to almost 20 during the decade ending with 1912. More persons die from murder and self-murder in this country every year than from either typhoid fever or diphtheria and croup. The annual loss of life on account of suicide in the United States may be conservatively placed at 15,000, and the average age of these unfortunates is approximately twenty years less than that in deaths from cancer. The subject of suicide has at all times attracted the attention of moralists and of spiritual leaders, but considering the awfulness of the crime of self-murder against God and man, it is a reflection upon our intelligence, our morality, and our conceptions of religious duty that so little should be heard in protest against this, perhaps the most sad and sorrowful phase of human life. The defense of suicide among the Stoics never gained ground among civilized peoples, but there has grown up a toleration and indifference, than which there is hardly anything more deplorable in our present-day period of what we are pleased to speak of as civilization. It has very beautifully been observed in this connection by a writer on self-murder, over two hundred years ago, that, "Whatever the end of human life is, what disputes soever there may be concerning it; it is not the destroying it; since nothing can have being given to it only in order to be not being." There is no more fitting subject for religious discourse than the sanctity of human life, the inviolability of the human person, the duty of facing life's problems with courage, and the ministry of suffering and sorrow as a means toward a more perfect spiritual attainment. There is nothing more deplorable in America than the contempt for life, as made evident by the waste of 15,000 lives through self-murder, and, in addition thereto, more than 6,000 lives ended each year by the murderous actions of others. The phenomena of murder and self-murder emphasize the practical value of a thorough understanding on the part at least of all those who are the responsible leaders in morality and religion of the elementary principles of law in the civil sense of the term, of the disorders of conduct biologically considered, of unsoundness of mind, and the border-land of insanity.

MORAL SIGNIFICANCE OF LIFE EXTENSION.

In other words, the conservation of human life and health, or, as said by Prof. Irving Fisher, the problem of life extension, is not only of economic, but also of great moral significance. The perfection of human character is, partly at least, conditioned by the maximum attainable duration of life, and old age is as essential to human development, moral and spiritual, as is the secular and religious education of youth.

ECONOMIC ASPECTS OF DISEASE.

Prolonged sickness, considered from this point of view, is frequently the cause of human failure, and premature death often terminates needlessly a most promising life. Sickness from preventable diseases is largely the result of social or individual indifference and neglect, but throughout the civilized world the importance of an effective sanitary administration is being recognized, and the principles of sanitary science are being locally applied, with increasing evidence of beneficial results.

REQUIRED CO-OPERATION FOR SOCIAL CONTROL.

The co-operation of the church has for some years been successfully enlisted in the nation-wide effort in behalf of the ministry of health. It has become the custom on the part of the churches to set aside at least one or two Sundays a year for emphasizing the importance of some great public health question, particularly, on the one hand, the need of adequate support for hospitals and other institutions of aid and relief, and, on the other, the urgency of financial and personal co-operation in the fight against tuberculosis. It would not seem to be going too far, therefore, to suggest that this principle of active co-operation should be extended and made to include a more frequent, though perhaps but incidental, discourse on other lamentable phases of human life, particularly, as previously said, the sorrowful and wholly irreligious indifference to the sanctity of human life, as evidenced in the increasing tendency toward murder and self-murder.

PROBLEMS OF MOTHERHOOD AND INFANT MORTALITY.

This view can be carried further and made also to apply to the unborn generations, or the sanctity of marriage as an institution primarily established for the preservation of the family and the continuity of the species. It can no longer be questioned that a vast amount of wrongful conduct underlies the persistent and considerable decline in the birth rate, and it can also not be questioned that a considerable portion of this decline is but life destruction, or murder under another name. Ignorance, however, is the cause of far more waste of child life than deliberate crime, and the still enormous mortality of infants forcibly suggests the necessity for radical changes in the education of young men and women preparatory to marriage and parenthood. Out of every 1,000 persons born, approximately 125 die during the first year of life, largely because of the gross and inexcusable ignorance of mothers whose training in the essentials of motherhood was unhappily neglected. But much of this loss of life is the result of sanitary inefficiency, of a polluted milk supply, on the one hand, and not infrequently of medical incompetence, on the other.

THE MINISTRY OF THE VISITING NURSE.

One of the most efficient aids in the campaign against infant mortality is the visiting nurse, assisting the young mother in the proper care of the child, and providing the required skilful assistance at a period than which there is none other so trying in a woman's life. The visiting-nurse movement is entitled to the most hearty moral and financial support, for the results of an efficient public nursing service benefit the children as well as the aged, and those suffering from slight ailments as well as those suffering from serious afflictions.

PROBLEMS OF CHILD CARE.

No subject appeals more powerfully to the sympathies of mankind of every degree than the physical sufferings of little children born with permanent defects in body or mind, and for all the years of their existence more or less a burden to society. No institution serves a more humane purpose than the orthopedic hospital, where the afflictions of the congenitally deformed, by means of skilful surgery, are reduced to a minimum of physical suffering and physical incompetence; where, in fact, the lame are frequently made to walk, just as in the corresponding institutions for the blind, the deaf, and the dumb, the defects of Nature are partly made good by the skill of man. The institutional phase of modern life is one of increasing importance, for the limitations of the home frequently preclude adequate treatment and care under the best possible conditions. The natural reluctance of parents to part with their children or of families to submit to the seclusion of a much beloved member in an institution for the treatment or cure of some mental or physical defect requires the strongest moral and spiritual support from those who are in the best position to give advice and lend a hand. In all such cases a reasonably thorough understanding of the fundamental facts of human life, the chances of death, the rate of disease frequency, the possibilities of cure, all combine to further the higher purposes of society, and bring about gradually, in however small a degree, the much required improvement in the conditions under which we live.

ALCOHOLISM AND HABIT-FORMING DRUGS.

Perhaps no problem of modern life is more serious in its moral and economic significance than alcoholism and the use of habit-forming drugs. If there is any one lesson taught by modern research into the biological laws which govern age, growth, and death, it is that the human organism cannot be abused or misused without the risk of most serious consequences and the practical certainty of physical impairment and premature death. The evidence is entirely conclusive that over-indulgence in alcoholic drinks is a fruitful cause of disease and moral depravity, while habit-forming drugs, including the misuse of tobacco, often and needlessly change a hopeful career into a hopeless human wreck. The most salutary influence is exercised by those who, by their own example, emphasize the value of right living; but this conclusion applies not only to moderation in the use of intoxicating drink, and much of what goes with it, but also to personal abuse or lack of restraint of every other kind, especially the pernicious habit of overeating, than which there is probably no more fruitful cause of bodily misery and premature physical decreptitude. It has been conclusively shown that those who are overweight live shorter lives and are more liable to diseases—possibly including one of the worst of human afflictions, that is, cancer—than do those who live abstemious lives, are careful in their diet and exercise restraint. The latter not only live longer, but, in the sum total of their years, enjoy a larger share of wellbeing than those who live contrarily to the obvious laws which govern the duration of the span of life allotted to us on earth.

THE FUNCTIONS OF OLD AGE.

Every agency or effort making for health improvement necessarily makes for a prolongation of life. Such prolongation of life is of variable value, according to the age period affected, and while humanely most obvious in infancy and early youth, it is economically most useful during the productive period of life, and spiritually in the later years, when the approach of natural death makes contemplation upon the problems of immortality, and possibly bodily survival after death, an imperative duty, the discharge of which can no longer be relegated to a future which, with certainty, we know is not to be. The utilization of old age, whether economic, social, or spiritual, is one of the most neglected phases of modern life. The neglect has its origin in the fact that in past generations relatively so small a proportion born attained to real old age that, as a practical question, the matter received only academic consideration. With the lowering of the death rate and the increasing average duration and the necessarily larger proportion of persons living into the third generation, this problem of old age and its proper utilization is, from many points of view, one of the most important of the time. The question need not be discussed here further, but it is sufficient to have pointed out its practical importance to the Church as well as to the State.

THE PROBLEM RESTATED.

The present population of the United States is not far from 100,000,000. The number of persons of both sexes, ages 70 and over, in 1910 was 2,270,021. According to the latest English life tables, out of every million born 277,351, or 27.7 per cent, may normally expect to reach the age of threescore and ten. In the United States the annual number of births is about 2,500,000, and the annual number of deaths is about 1,350,000. Of those who died during 1912, approximately 236,500, or 17.6 per cent, had lived less than one year, and 329,400, or 24.4 per cent, had lived less than five years.

The principal causes of death, in the order of their numerical importance and the approximate annual mortality therefrom are as follows: first, tuberculosis, which affects every period of life and causes in the aggregate about 154,000 deaths; second, heart diseases, also affecting every period of life, but chiefly ages over 40, causing a mortality of about 150,000; third, nervous diseases, which account for about 138,000 deaths; fourth, pneumonia (all forms), about 132,000; fifth, intestinal diseases, about 123,000; and, sixth, genito-urinary diseases, about 111,000. Following these six, in the order of importance, are accidents, causing about 182,000 deaths; and tumors, malignant and benign, about 75,000. These eight groups of causes combined account for about 72 per cent of the aggregate mortality of the United States, which, as previously stated, is approximately 1,350,000 per annum. Other important causes are typhoid fever, the mortality from which is about 20,000 per annum; suicides, numbering approximately 16,000; deaths from parturition, about 15,000; and homicides, of which there are from six to seven thousand.

This may be considered the normal mortality of a civilized country not subject to exceptional or uncontrollable mortality conditions, such, for illustration, as continue to affect a great country like India, even at the present time. The death rate of the registration area of the United States during 1912 was only 13.9 per 1,000, against a death rate of 32 for British India. Of the 7,500,000 deaths, in round numbers, during the year 1911, 354,000 were caused by cholera, 58,000 by smallpox, 733,000 by plague, and 4,200,000 by fevers. Most of these causes are no longer an affliction of modern civilized countries, and they are fortunately brought slowly under control in the Indian Empire, where the death rate has gradually been reduced from extraordinary proportions to a rate not much above the normal for the large cities of this country fifty years ago. The best illustration of India's marvelous sanitary progress is to be found in the reduction of the death rate of the European army during recent years. Military discipline and conformity to sanitary rules and regulations, no doubt, largely account for this reduction, which has been of immeasurable benefit, not only to the European, but also to the native population.

The Stackhouse Antarctic Expedition now expects to sail from England August 1st, 1914, in Capt. Scott's old ship, the "Discovery." The start will probably be made from London Bridge, so as to enable the public to witness the departure and give the explorers a hearty send-off. Besides the officers and crew of the ship, numbering 25, there will be about five scientific men attached to the expedition. Lieut. A. E. Harbord, R. N., will be in command of the "Discovery." The scientific staff is to include two noblemen, Lord Congleton, who goes as surveyor, and the master of Sempill. All the officers and scentists will give their services.

The Preservation of Wood—I*

A Synopsis of the Principal Processes in Use To-day

By A. J. Wallis-Tayler

INTRODUCTION.

THE value of wood preservation is now thoroughly recognized, and its importance in the industrial world is rapidly increasing. The advancing cost of lumber has brought home to the consumer the fact that the only possible offset to this enhanced cost is the use of preservative methods to prevent, or rather to retard, decay; and thus not only to lengthen the life of the wood in all its forms, but also to widen the field by bringing into use a number of less valuable species of timber.

In the United States, where, a comparatively few years ago, the supply of timber seemed all but inexhaustible, the amount of lumber now available hardly meets the ever-increasing demand in a satisfactory manner. This is due to careless lumbering, to failure to replant denuded areas, and to the enormous waste caused by forest fires. These remarks are also more or less applicable to other timber countries.

Once divested of life, vegetable substances, in conjunction with animal substances, are liable to decay. Some kinds of wood are more apt to deteriorate rapidly than others, but all woods, under certain conditions, become deprived of the fibrous textures, and thus lose their properties.

Wood consists essentially of vessels and cells, the only solid parts being the coats which form them. In these vessels is the sap, the circulation of which through the tree is the source of its existence. On the death of the tree, however, the sap in the wood is liable to cause vegetable decomposition through the process of fermentation. The fact that putrefactive fermentation, and the subsequent decomposition of vegetable matter, are due to albumen, was discovered by Kyan, the inventor of the "kyanizing" process of preserving wood.

The most common causes of decay are the presence of sap and being subjected to alternating conditions of wetness and dryness, or to a combination of moisture, heat, and absence of ventilation.

Two kinds of decay are distinguished—"wet rot" and "dry or sap rot." The former, which may occur while the tree is standing, takes place where the gases evolved, principally carbonic acid and hydrogen, can escape the tissues of the wood, the sappy portions especially becoming decomposed. The latter, which takes place only in dead wood, occurs in confined places, where the gases evolved, finding it impossible to escape, enter into new combinations and produce fungi, which derive their nourishment from, and thus destroy, the wood. The following illustrations, reproduced from Allis-Chalmers Bulletin No. 1439, July, 1909, show in Fig. 1 a wood-destroying fungus (Lentinus Lepidus) on a red fir sleeper in South Dakota, and in Fig. 2 the growth of destructive fungus on an untreated white oak sleeper.

By felling the timber at the proper season, and at the most suitable age, the tendency to decay can be somewhat reduced. For destruction due to the ravages of insects the only remedy is treatment with some preventive agent. Figs. 3 and 4 show two untreated oak piles destroyed by the teredo navalis, the latter a portion of a pile after only two years' service.

The lower forms of animal and vegetable life, that is to say bacteria, fungi, or spores, assisted by heat, air, and moisture, enter the wood cells and destroy the wood tissue, and as these destructive elements are always present and ready to attack organic matter, it becomes necessary both to destroy them and to render the wood impervious to them, by the injection of some antiseptic or poison in liquid form.

The processes for the preservation of timber from decay, and from destruction through the boring of insects, may be classified under three headings: Drying artificially and hermetical protection from contact with the atmosphere by coating the surface with paint; the elimination of the sap of the wood by dilution or vaporization; the impregnation of the wood with some antiseptic chemical substance which will form an insoluble compound with the organic matters in the sap.

The first and second of the above methods are only valuable where the timber is comparatively thin, is so placed as to be readily accessible, and is not in contact with the ground. The third is the most important, and it is proposed to deal chiefly with processes coming under this head.

* Paper read before the Royal Society of Arts and published in its *Journal*.

EARLY HISTORY OF THE ART OF WOOD PRESERVATION.

The art of wood preservation is probably one of very great antiquity, and is believed to have been practised by the ancient Egyptians, wooden coffins used by them, estimated to be at the very least 2,000 years old, having been found in good preservation. Wooden dowel-pins were also employed in the stonework of the ancient Egyptian temples, the age of which is undoubtedly over 4,000 years. These latter are probably the oldest pieces of wood existing in the world at the present time, and

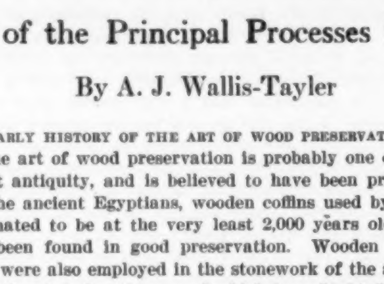

Fig. 1.—Wood-destroying fungus (Lentinus Lepidus) on fir tie.

are thought to have been treated with some preservative agent, probably bitumen.

Among the pioneer investigators into the subject of preservative agents was Johann Glauber, of Carlsbad, Germany, a celebrated chemist in his day. Glauber's experiments were made about 1657, and his process consisted in first carbonizing the wood under the action of fire, then coating the surface with tar, and subsequently immersing the wood so treated in pyroligneous acid or crude acetic acid.

Since the date of Glauber's experiments, numerous processes for the preservation of wood have been devised, many of which would doubtless be efficient for the purpose, the only question being the commercial one as to the possibility of economical application. The earlier investigators, however, whose processes gave the most satisfactory results, were those who carried out their experiments in the decade between the years 1830 and 1840, and three processes dating from that period have survived to the present time, viz., the corrosive sublimate or mercuric chloride ($HgCl_2$), or kyanizing process; the dead oil of tar or creosote oil, or creosoting process; and the chloride of zinc ($ZnCl_2$), or burnettizing process. The first, or kyanizing process, is now less frequently employed owing to the greater cost of the agent and the longer time required to carry it out.

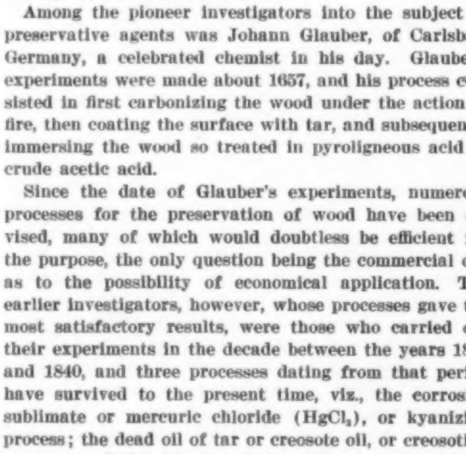

Fig. 2.—Growth of destructive fungus on untreated white oak tie. Figs. 3 and 4.—Untreated oak piles destroyed by Teredo Navalis, the latter after only two years' service.

The first experimenter to employ pressure for the purpose of forcing antiseptics into wood by means of hydraulic pressure is said to have been a Frenchman named Breant in 1831. In 1846 the plan of previously steaming the wood was introduced by Pain.

CONDITIONS NECESSARY TO INSURE SUCCESS.

Two conditions are absolutely necessary in order that an antiseptic agent should produce useful results in the preservation of wood, viz., a proper liquid state at the instant at which injection into the wood takes place, and a reasonable cost.

It is also essential that the operator should have a thorough insight into the practical working of the process employed, and a knowledge of the nature of the preservative used.

The wood to be treated should, moreover, be in a proper condition, that is to say, properly seasoned or at the very least half seasoned. In the best practice in Europe the wood is not treated until it has been seasoned from six to twelve months. In the United States, however, wood is usually treated from four to six months after cutting, and generally with inferior results.

THE ABSORPTION OF PRESERVATIVES BY TIMBER.

The whole problem involved in timber preservation is the replacement of the sap of the wood by some suitable preservative agent, and before proceeding to discuss the various antiseptics and systems of application employed, a few observations upon the fundamental factors controlling the penetration of preservatives into wood may materially assist in clearing away some of the difficulties that occasionally confront those interested in the timber-preserving industry, through results being obtained in practical working which cannot be satisfactorily explained.

With this object in view the writer thinks that he cannot do better than give some brief abstracts from two papers on "The Preservative Treatment of Wood," by Mr. Irving W. Bailey, Assistant Professor of Wood Technology, Harvard School of Forestry, which papers appeared as contributions from the laboratory of wood technology of the above school, in a recent number (Vol. XI, No. 1, March, 1913) of the *Forestry Quarterly*, a professional journal published in Ithaca, N. Y. The writer has to thank Prof. Bailey for his courtesy in lending him the original negatives, so as to enable him to take prints from which the photomicrographs Figs. 5 and 7 have been prepared, and he would also observe that the above papers would well repay perusal *in extenso* by those interested in the subject.

The first of these articles treats of the validity of certain theories concerning the penetration of gases and preservatives into seasoned wood. The author analyzes Tiemann's theory, which he summaries as follows: "In fresh green wood of all species the cells of all kinds (except the resin ducts and the vessels) are completely closed by the primary wall, and the gases cannot be forced through this inclosing membrane even at extreme pressures. Water may percolate through this membrane gradually, as through a filter, but this action must be comparatively slow even under high pressure. . . . Whenever wood seasons (beyond its fiber saturation point), whether naturally or by artificial means, narrow microscopical slits occur in the walls of the fibers and tracheids which render them penetrable to gases and liquids. These slits do not reunite when the wood is resoaked, although they may close up somewhat. The greater the degree of dryness the more penetrable the wood becomes. . . . Steaming opens up these slits in the cell walls, but they are not as numerous nor as wide as in air-dried material."

The greater penetration of creosote in dense woods and in heavy "summer-wood" of long-leaf pine paving-blocks is explained by Mr. H. F. Weiss by the fact that dense tissue cracks more in drying. Such splitting, he says, does not occur to the same extent on the light thin walls, as they seem to yield and bend more under readjustment of the wood during drying. The heavy walls it seems, therefore, cannot readily adjust themselves to moisture changes, and consequently split somewhat in the manner of a tie when it dries too rapidly.

The subject is discussed at some length, the following summary and conclusions having been arrived at:

1. Spiral cracks in the walls of tracheids and fibers occur in only a small percentage of dry wood.

2. Spiral cracks, when present, are confined in co-

niferous woods to the heavy, thick-walled tracheids at the end of the year's growth.

3. Spiral cracks are confined to the secondary and tertiary layers of the cell wall, and the primary wall remains unruptured.

4. Air passes as easily through dry cells whose walls are unruptured as through cells whose secondary walls have cracked in drying.

5. In many cases air cannot be passed through dried cells whose secondary walls possess well-developed "slits," or cracks.

6. Although drying cracks or "slits" do not close when dry wood is thoroughly resoaked, resoaked wood is in many cases as impervious to air as unseasoned material.

7. Although air cannot be forced through long pieces of green coniferous wood even under heavy pressures, it passes in many cases through short pieces of more than one fiber length.

8. In long-leaf pine paving-blocks, when the penetration was confined largely to the dense bands of "Summer-wood," the walls of the latter were, in the majority of cases, found to be unruptured.

From this it is held to be clear that Tiemann's "slit" hypothesis cannot account for the penetration of gases and oils into seasoned woods. Similarly, Weiss's theory cannot account for the greater penetration of preservatives into dense tissues. In both cases some undetermined factor, or factors, are at work which control the injection phenomena.

Fig. 5 shows at *D* a radial longitudinal section of a western hard pine showing spiral cracks or "slits" in the thick walls of the "Summer-wood." The thin-walled spring tracheid at the right is seen to be unruptured. (*E*) A cross section of the dense fibers of a broad-leaved tree, or "hardwood," showing drying cracks in the thick secondary walls. The darker colored primary walls which inclose the inner layer are seen to be unruptured. (*F*) A tangential longitudinal section of the "Summer-wood" of western yellow pine showing spiral cracks or "slits." (*G*) A cross section of both the "Summer" and "Spring-wood" of a Mexican hard pine. The cracks or "slits" are confined to the thick secondary wall of the "Summer-wood." The dark primary walls are seen to be unruptured. (*H*) A longitudinal section of freshly-cut white pine sap-wood, taken from the immediate vicinity of the cambium, showing the fine spiral bands which occur in specialized cells that resist compression. (*J*) A longitudinal section of loblolly pine tracheids, showing striated effect produced by incipient stages of decay. (*K*) A cross section of the air-dried "Summer-wood" of a very dense specimen of long-leaf pine. The thick secondary wall, as well as the primary and tertiary walls, is seen to be unruptured (compare *G*). The first faint lines crossing the section from right to left were made by the minute irregularities which occur on the edge of even the sharpest microtome knife.

In the second article, Mr. Bailey deals with the structure of the pit membranes in the tracheids of conifers, and their relation to the penetration of gases, liquids,

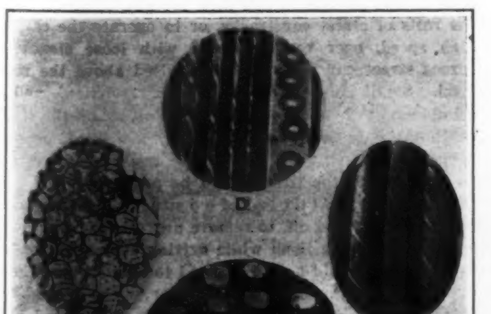

Fig. 5.—Photomicrographs illustrating validity of slit hypothesis.

and finely-divided solids, into green and seasoned wood, the following summary and conclusions being arrived at:

1. Wood is a highly specialized and complex plant tissue, designed primarily to conduct aqueous solutions and to give strength and rigidity to stem and branches.

2. It is extremely variable in different species and even in different parts of the same individual, owing to variations in the functions which it is called upon to perform.

3. Coniferous woods, or "soft woods," are composed largely of minute cells, or tubes, with closed ends.

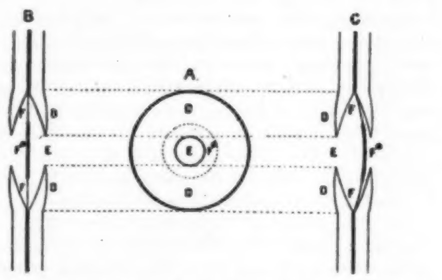

Fig. 6.—Diagram showing structure of bordered pit.

Liquids, in passing through this tissue, travel primarily in the cavities of the cells, and pass from cell to cell by means of delicately constructed valves or bordered pits in the cell walls.

4. The membranes of the bordered pits are not always entire, as has been previously supposed, but possess (in all species examined) numerous minute perforations, whose presence may be demonstrated by careful microscopic examination and by experimental means.

5. When wood is thoroughly dried, no structural modification, such as the rupturing of the cell walls, is essential in order to account for the penetration of gases and preservatives into seasoned wood.

6. In green wood, the bordered pits and membranes are very permeable to aqueous solutions, but are comparatively impervious to undissolved gases, and to oils, and other heavy or viscous liquids. This is due, undoubtedly, to capillary or surface tension phenomena and the valve-like action of the torus.

7. Dry wood (except when the cells are clogged with resins or other secretions) is very permeable to gases, since water is no longer present to resist the passage of the gases through the perforations in the pit membranes.

8. Whenever preservatives are injected rapidly into green or seasoned wood, the penetration takes place primarily through the cavities of the cells, and the preservatives pass from one cell to another through the bordered pits.

9. Rupturing of the pit membranes was found in some specimens to be concomitant with the process of drying, and may account for the fact that in certain cases resoaked dry wood is less impervious to air than green material.

10. The impregnation of wood by modern commercial methods is a complicated chemical, physical, and anatomical problem, since any given phenomenon may be the result of numerous interesting chemical, physical, and anatomical factors.

Fig. 6 shows diagrammatically the structure of bordered pit: *A* being a surface view of bordered pit; *B* and *C*, sectional views of bordered pits; *D*, embossed or bordered area of secondary wall; *E*, pit or orifice in secondary wall; *F*, membrane; *F**, thickened area of membrane or torus.

Fig. 7 shows at *L* a tangential section of sequoia showing sectional view of the bordered pits. The membrane and torus are seen to occupy a medium position between the two arching cell walls. (*M*) Tangential section of hard pine showing sectional view of bordered pits. The tori have been pressed against the left-hand orifices by excessive pressure. (*N*) Tangential section of hard pine showing sectional view of bordered pits. The torus in this case is thin and flexible and has been jammed into the right-hand orifice so firmly that it appears bow-shaped. (*O*) Tangential section of freshly cut green white pine sapwood injected with a carbon mass. The minute carbon particles are seen to penetrate from one cell to another by the bordered pits. (*P*) Tangential section of sequoia heartwood showing the penetration of carbon mass from one tracheid to another through the numerous bordered pits. (*R*) Tangential section of the Summer-wood of a common long-leaf pine paving block. The heavy tar oils are seen to penetrate by means of the bordered pits. (*S*) Diagrammatic drawing of pit membrane and torus. The perforations are seen to occur in the thinner bands of membrane substance. (*T*) Radial section of freshly cut green white pine sapwood treated with a carbon mass. The carbon particles are seen to penetrate the pit membrane in a rim about the torus, and in lines radiating outward from it. (*U*) Radial section of larch showing large perforations in the pit membranes.

VARIOUS PROCESSES EMPLOYED FOR PRESERVING WOOD.

The Bichloride of Mercury Process or "Kyanizing."—The preservative process usually known as "kyanizing," from the name of the inventor, John Howard Kyan, who introduced it into this country in the year 1832, consists in steeping or soaking the wood in a solution of bichloride of mercury or corrosive sublimate ($HgCl_2$), the solution generally used consisting of 1 pound of the salt to 99 pounds of water.

In the year 1836 this process was introduced in Woolwich by the Royal Engineers, but it has now practically gone out of use in England. The chief objections to the process are the high cost of the agent, and that, being carried out without pressure, it is a very slow one, occupying as many days as the pressure processes do hours. According to Mr. Samuel M. Rowe, an authority on the preservation of timber in America, the usual rule there—where the process has recently been carried on in some localities owing to chloride of zinc and dead oil of tar or creosote oil for the "burnettizing" and creosoting processes not being readily available—is to allow the wood to steep in vats for a length of time depending upon its least thickness, thus if the timber is 10 inches by 12 inches thick it would remain in the vats eleven days; if 6 inches by 9 inches it would steep for seven days.

Owing to the bichloride of mercury used as the antiseptic in this process containing hydrochloric or muriatic acid (HCl), which acts injuriously on iron, it has been found impracticable to attempt to impregnate the wood under pressure.

The price of corrosive sublimate is about 3s. 6d. per pound, against 4d. per gallon for creosote oil, and about 2d. per pound for pure chloride of zinc.

The Zinc-chloride Process or "Burnettizing."—Sir William Burnett's invention, known as "burnettizing," was introduced in 1838, and the process consists briefly in the destruction of the tendency possessed by certain vegetable and animal substances to decay, by subjecting them to the action of chloride of zinc ($ZnCl_2$). The degree of dilution recommended by the inventor is 1 part by volume to 50 parts of water, and the impregnation is now most commonly carried out under a pressure of 7 or 8 atmospheres, as used in creosoting. In Germany, where the process is probably the most used, the wood is steamed under a pressure of from 60 pounds to 70 pounds per square inch, preparatory to burnettizing. The solution employed is generally composed of 2.5 per cent of zinc chloride and 97.5 per cent of water.

In the United States the solution most commonly used consists of 0.5 pound of dry zinc per cubic foot of wood treated. The wood to be treated is first air-seasoned in the open or steamed in closed retorts to expel moisture. The first stage of the cycle consists in

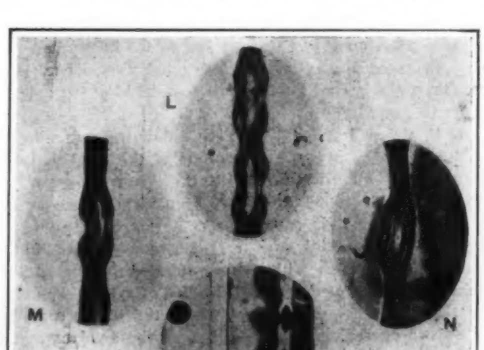

Fig. 7.—Photomicrographs illustrating structure of pit membranes in conifers.

subjecting the wood in the retort to a vacuum, which is maintained until the solution is introduced, and the wood is completely submerged. Additional solution is then pumped in and the pressure increased to about 100 pounds or 125 pounds per square inch, until the required amount of penetration and impregnation is obtained, and the remaining solution is then drained from the retort.

The solution used consists of a combination of zinc spelter with hydrochloric acid, leaving no free acid. The strength of the solution is perhaps best arrived at by experiments with the particular wood to be treated.

It is important that the zinc-chloride should be as free from all impurities of any kind as is practicable, being basic and devoid of free acid. The commercial chloride is dissolved, shortly before being required for use, into a concentrated stock solution from 35 to 50 per cent in strength to insure thorough dissolving, any free acid being taken up by the spelter placed in the vat. The diluted solution is made by the addition of the requisite amount of water to this stock solution, the most convenient method of testing the strength of the solution being the Beaumé hydrometer.

The full programme of the process is as follows: Steaming to 20 pounds pressure per square inch for 30 minutes; steaming from 20 pounds to 35 pounds pressure per square inch for 3 hours 30 minutes; blowing off steam, 15 minutes; vacuum, 45 minutes; solution to about 100 pounds pressure per square inch, 45 minutes; solution maintained at 100 pounds pressure per square inch, 1 hour 15 minutes; forcing back solution, 15 minutes; total time, 7 hours 15 minutes; or, if the steaming time be reduced by 2 hours, 5 hours 15 minutes.

The principal recommendation possessed by this agent is that of cheapness. It possesses no value for the protection of piles or timber against the attack of marine worms, although it is said to be useful as an aid to the impregnation of piles, etc., with creosote.

When timber impregnated with zinc-chloride is subjected to wet, a certain amount of the agent washes or leaches out, the percentage of loss gradually diminishing. This last does not appear, however, on investigation to be so serious a matter as it would seem at first sight. Experiments, described in the *Engineering News*, made by Mr. Octave Chanute with wood treated by the zinc-chloride process, during which efforts were made to extract the preservative by long-continued and oft-repeated series of immersions in water, showed on drying and analyzing that, although a small, regularly decreasing amount does waste out, after about 18 months of strenuous treatment, only 28 per cent of that originally absorbed was extracted.

The appliances required for carrying out the zinc-chloride process are practically the same as those used for "creosoting," except that for the latter process a storage tank will be required for receiving the oil, and that the retort or impregnating cylinder is fitted with steam-heating pipes to maintain the necessary fluidity of the oil. The main pipes through which the oil is passed should also, for the latter process, be heated by internal steam-pipes for the same purpose.

The Zinc-tannin or Wellhouse Process.—This process consists in subjecting the wood to be treated to the action of steam in a retort or impregnating cylinder for a period sufficient to open the pores and expel the natural saps, followed by a vacuum of from 18 to 26 inches to withdraw the vapors and free the wood from the condensed steam and volatilized saps. The antiseptic agent consists of a solution of zinc-chloride of a strength of from 1.5 to 3 per cent, according to the nature of the wood, with a proportion of dissolved glue equal to one half of 1 per cent. (The Allis-Chalmers Company gives the proportions as 0.5 pound of dry zinc-chloride plus 0.5 per cent of glue or gelatine per cubic foot of wood.) The solution is held in the retort at a pressure of from 100 pounds to 125 pounds per square inch for 2½ to 6 hours, after which it is forced back into the storage tank and a ½ per cent solution of tannin or tannic acid ($C_{14}H_{10}O_{9}$) is introduced and held under the same pressure as before for about two hours. After the withdrawal of the latter the operation is complete.

In some works the practice of introducing the glue in a separate solution is adopted: this necessitates the provision of another storage tank.

The zinc-chloride solution is the same as used in the zinc-chloride process. The glue employed is the ordinary article of commerce; those glues, however, having the highest percentage of gelatine being preferable. The tannic acid generally consists of an extract of hemlock bark. From 25 to 30 per cent of pure tannic acid should be present. The amount of the glue and tannin should be one tenth of the amount of pure chloride used, the proportions of glue and tannin being such as to insure the absorption of the prescribed amount of pure chloride per cubic foot of wood. The amount of glue should be at least 1 per cent in weight of the whole amount of chloride solution. The strength of the tannin solution should be at least 1 per cent in weight of the whole contents holding the tannin solution.

The time occupied in treating the wood by this process is, for ties or sleepers, omitting steaming, 4½ hours, with steaming, 6½ to 8½ hours; for timber, omitting steaming, 5½ hours, with steaming, 8½ to 13½ hours.

The zinc-tannin process differs only from the "burnettizing" process in the addition of the glue and the subsequent treatment with tannin solution. The glue and tannic acid combine and form a leathery and insoluble product claimed to assist in rendering the wood impervious to the absorption and giving off of moisture, and thus to prevent the zinc-chloride from leaking or being washed out.

The plant required for the zinc-tannin wood-preserving process is practically the same as that used for the "burnettizing process.

(To be continued.)

Tires*

The tire is a highly important factor in motor-car operation, and safety in the handling of the car can hardly be expected unless the tires are kept in good condition. The cost of a new set of tires is so heavy that owners are tempted to postpone renewal as long as they can persuade themselves that it is safe to do so, and economy and safety are therefore closely related, when the tire problem is under consideration. Ever since the introduction of the automobile, manufacturers and owners of cars have sought a substitute for the expensive rubber, and the rapidly increasing use of the automobile has emphasized this demand and made it more insistent. The numerous rewards and prizes that have been offered for the discovery of a cheap and satisfactory substitute, and the alluring promise of commercial gain that such a discovery holds out, have stimulated inventive minds to a wonderful degree, and have resulted in the exploiting of a number of substances; but none of them, so far as we know, has yet demonstrated its value by protracted experience, and the prospect is that rubber will remain king for a long time to come.

It is almost impossible to give a definite and reliable estimate of the average percentage of the total maintenance cost of an automobile that can properly be charged to tires. Figures have been given, however, in which the tire item ranges from 20 per cent to 50 per cent for commercial cars, and between similar limits for pleasure cars. This wide variation is due to the many factors that determine the life of a tire. The size of the tire, the weight of the wheel and of the car, the speed of operation, the condition of the roadway, and numerous other things, all have a direct bearing upon the tire mileage, and it is easy to see that the tire problem must necessarily be a complex and difficult one. The mileage may be greatly increased, however, by heeding the advice given by the tire manufacturers, and by exercising good judgment in the care of the tires.

A familiar example of poor judgment, which may be seen almost any day in our cities, consists in running a car up too close to the curb. Some drivers take pride in their ability to bring a passenger car so close to the curb that there is barely a crack left between the two; but it is unwise to practise this, because a slight miscalculation will cause the front wheel to rub against the curbstone, and the rear wheel on the same side is usually subject to a similar rub when the car turns out into the street again. The abrasion caused by the friction of the tire with the rough surface of the curbstone weakens that section of the tire, and continued action of this kind may reduce the strength of the casing so materially that a blow-out will soon follow, perhaps with serious consequences. A driver who stops his car at a distance of one foot from the curb certainly avoids the risk of injuring the tires; and although we emphatically disclaim any exact knowledge of the distance that a woman can step in a modern narrow skirt, we strongly suspect that she could negotiate an interval of twelve inches without danger, even if she were clothed in the extremest of the feminine fashions of the day.

The wear on the tires depends to a large extent upon the nature of the road, the weight of the wheels, and the speed at which the car is run. In general, the heavier the wheel the higher its rebound when it meets an obstruction. Between the instant that the wheels leave the roadway and the instant that they touch it again they are free from the friction of road contact, and during this brief interval the load on the engine is released. Hence there is a momentary speeding up of the driving wheels. When they again come in contact with the road they are revolving faster than when they left it, and they must therefore slip to some extent before they are again turning in conformity with the speed of the car. This action may be imperceptible in any one case, but the aggregate effect of it during, say, 5,000 miles of travel is serious, and distinctly detrimental to the tires.

Many persons neglect to inflate their tires to the pressure recommended by the manufacturers, because the car rides more comfortably on under-inflated tires. This is a mistake, as insufficient inflation shortens the life of the tires, and causes a great deal of trouble. Rim-cutting is the usual result of insufficient pressure, and if the car is heavily loaded the tires may be damaged beyond repair in a comparatively short time.

In addition to tire deterioration from the causes mentioned above, there is the ever-present danger of a cut or a puncture. A tire coming in contact with an object having a cutting edge is likely to receive a more or less damaging slit, which unless it is promptly repaired, gradually extends and weakens the shoe. It is then only a question of time before a blow-out occurs. Small punctures are less serious than blowouts, but they are very annoying, especially on hot, dusty days, and a great deal of ingenuity has been expended in the effort to produce a puncture-proof tire. The difficulty is, to obtain a durable and reliable tire, of reasonable cost and simple construction, without sacrificing resilience.

Many automobile accidents are due to the skidding or slipping of the wheels. When a driver is obliged to make a sudden stop or turn while running on a slippery pavement the chances are that the car will slip or skid before responding properly to his efforts. The skidding is most marked when the rear wheels spin around on account of the roadbed being slippery, resistance to sidewise displacement being greatly reduced, in accordance with well-known mechanical principles, by the rapid rotational slipping. In order to minimize dangers of this kind, tire manufacturers have placed on the market so-called non-skidding or non-slipping tires. Various designs are used by the different makers, but the general idea is to mold a series of projections on the face of the tire, so as to roughen its surface and enable it to seize more effectively upon the irregularities of the road. Chain attachments are quite commonly employed for the same purpose, and they are especially useful in winter, because they not only diminish the skidding, but also increase the tractive power of the car in snow and mud.

Attention to the following suggestions will materially prolong the life of the tires, and will thereby promote safety also.

Care should be taken to avoid letting the clutch in quickly when the car is at rest, because the sudden application of power may make the rear wheels revolve rapidly before the car gets under way, and causes serious and totally needless wear on the tires. A similar effect is produced by applying the brakes too suddenly when the car is in motion, and thereby locking the rear wheels so that the car slides. It is injurious to the tires to run on them when they are flat, or to drive on the rails of street car tracks, or to operate the car, at high speed, over roads covered with loose stones or across street car rails that are raised above the road level. Small cuts should be promptly repaired, and a reliable gage should be used when blowing up the tires, so that the pressure to which they are filled may be properly regulated. Oil and grease are very destructive to rubber, and the tires should be protected from contact with them. At the end of a journey the tires should be carefully wiped off, to remove any oil that may have accumulated upon them while driving over oiled roads; and the car should not be allowed to stand where there are pools of water or oil on the floor or the ground. If a blowout or a serious puncture occurs on the road, and the driver has no more inner tubes, it is sometimes advantageous to remove the damaged tube and fill the casing as solidly as possible with hay or grass or some other similar material. An expedient of this kind should not be adopted unless the situation is serious, but it is better than attempting to run on the flat casing, or on the rim of the wheel after the casing has been removed. It is hardly necessary to state that the car should be driven slowly and carefully while operating under these conditions, and that repairs should be made, or new tires procured, at the earliest opportunity.

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The Electrical Conductivity of Copper

The electrical conductivity of copper depends upon the total amount of impurities, and not upon any one element. This is why the conductivity test is so valuable in determining the purity of copper. The aggregate of all impurities is shown, and thus the purity of the copper indicated. Amounts of impurities that will defy detection, or would never be known to exist by chemical analysis, are found when the electrical conductivity test is applied.

A New Wright Aeroboat

A Marine Aeroplane of the Pontoon Type

The latest Wright aeroboat known as type "G" belongs to the class of three pontoon marine aeroplanes, the center pontoon, or hull, furnishing most of the flotation, while the smaller pontoons attached to either wing end do their share in supporting the craft. No special hydroplane paddles, however, are attached to these auxiliary end pontoons, as their use has been found unnecessary.

The motor seats and other parts are placed entirely above the deck which seals the top of the pontoon. At the same time the sides of the hull are carried above this watertight deck to the height of the wings, and form an enclosed body for the motor and seats, protecting them very effectively from spray and waves.

The motor is situated in the front, motorcar fashion, and the seats, side by side, are back of the motor and situated at the center of the wings. At the rear of the main wings are the two propellers, and beyond these the rudders, which are carried on a tail frame, from the center section.

Under the seats and above the step of the hydroplane pontoon are large air tubes, which pass from the deck through the bottom of the hull. These tubes serve not only to ventilate the step, but to drain the cock-pit in which the seats are located, of any water shipped in bad weather. This feature is similar in arrangement to that of self-bailing lifeboats.

It is interesting to note that in tests of the Navy aeroboat made at Toledo recently, the passenger carried was able quite easily to open up the engine hatches, examine the engine while in flight, and make minor adjustments. It would even be possible to replace spark plugs while the machine is in operation in the air.

The boat hull itself is 19 feet long, and at its widest has a beam of 43 inches. The height of the hull is such as to give a clearance to the tips of the wings of 3½ feet above the water surface when hydroplaning, which gives splendid rough sea qualities, and makes the possibility of catching a wing in rough water quite remote. Over the engine the metal covering is made in the form of two large hatches, which slide in and out. When removed these hatches give access to the engine, and when closed serve as a practical watertight covering. With this arrangement built as strongly as it is on the new aeroboat, it is possible for the craft to plunge head-on into a large wave without having the water stop the running of the engine or causing any detrimental effect.

The wings of the aeroboat are 38 feet in span and 6 feet in chord, with a distance between planes of 5 feet. The main carrying surface is 430 square feet in area. The interior construction of the wings themselves, like most other details in the machine, has been much improved over previous practice. The ribs are made solid of I-beam shape, and the spars are increased in depth. The thickness of the wing is very much greater than in previous designs, thus adding to the strength. The wings are covered with a special grade of linen, treated with a preparation which gives to the linen a smooth finish that is not only weather-proof, but is proof against seas. The struts, of a splendid streamline form, are of ample cross-section, and the important sustaining wires throughout the craft are doubled, there having been introduced an entire duplicate system for the main warping wires as well.

An interesting feature in connection with the wing construction is the new type of joints adopted for connecting the wires to the struts and planes. These joints consist simply of a hook-shaped plate of great strength, into which the eye of the wire fits. This has permitted of the entire elimination of the number of bolts and pins which are ordinarily employed, and has thereby greatly increased the safety of the machine.

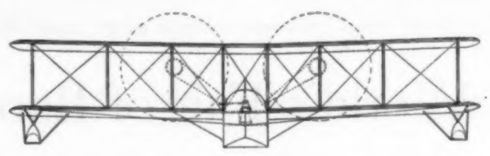
It is of importance to note that the wings are not divided at the center, as is customary, the spars at the boat being continuous, from one wing to the other. This feature has eliminated the body joints, which are a source not only of added weight, but of considerable danger because of the great strains at this point.

At the tips of the wings are mounted on either side the auxiliary pontoons, which help to float the machine. These pontoons are attached to the lower wing spars by strong steel braces, and are themselves merely smaller duplicates of the central boat in construction.

The control of the wings and rudders in the new type is in duplicate, and provision has been made for mounting either the customary Wright lever control or the new Wright wheel control.

The rudders of the Wright aeroboat are exceedingly novel in form and very powerful in size. The rudders for the direction of the machine are pivoted on two steel tubes, which form the rear struts of the tail frame supporting the rudders, a convenient arrangement which has helped greatly to reduce head resistance. These twin rudders work in unison, being suitably connected by cross wires. The area of the direction rudders totals over 22 square feet.

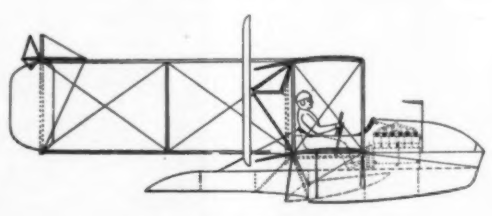
The elevator, of the new Wright inherent stability type, is carried very high, being attached to the top of the rectangular tail frame above the two rudders. This feature has greatly added to the natural tendency in



Front view of Wright aeroboat.

the balance of the machine to overcome the high thrust of the propellers. The elevator in type "G" has 16 feet span and a total area of 53 square feet. The construction of both the elevator and the rudders is similar to that of the wings, and ample bracing has been provided to avoid vibration.

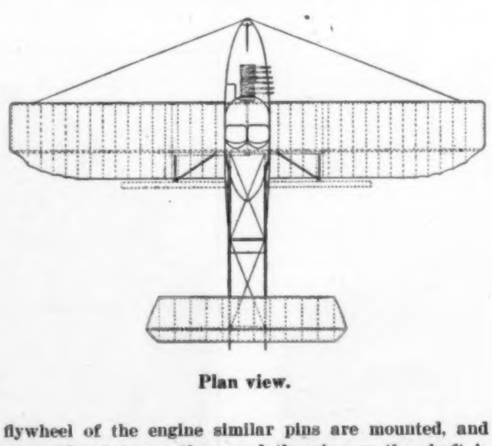
The transmission on the new Wright aeroboat has introduced many refined engineering problems, in which the experience of the Wrights in this kind of work has resulted in a remarkably successful drive. As customary in Wright practice, two propellers are used, rotating in opposite directions, and, in the case of the aeroboat, the increase in efficiency that is obtained thereby is even more valuable than on land machines. The propellers are 8 feet 6 inches in diameter, and



Side elevation.

rotate approximately at 580 revolutions per minute. They are driven by chains from the central drive shaft, one of the chains being crossed. The shafts are so distanced by guides and radius rods as to permit of easy alinement.

The central drive shaft passing under the seat drives the propellers from the engine, situated in front. At the front end there is mounted the new Wright shock-absorbing drive, a feature new to aviation, which is an application of the highest engineering principles, and is a step in the progress of aeroplane construction that has considerable significance. This shaft carries at its end a steel cone upon which are mounted pins. On the



Plan view.

flywheel of the engine similar pins are mounted, and connection between these and the pins on the shaft is made by eight shock absorbers. The shaft cone is free to rotate in relation to the flywheel, but the two are restrained by the shock absorbers, these being the only direct connection between the engine and the transmission. As a consequence, the power of the engine is entirely transmitted to the rest of the machine by these shock absorbers. The introduction of this elastic element has not only rendered it possible to greatly reduce the weight necessary in the transmission to resist the severe strains of the engine, but has also greatly lengthened the life of the mechanism.

The weight of the entire aeroboat, empty, is 1,300 pounds, a record in construction in machines of this size and strength. The motor is a 6-cylinder 60 horse-power Wright.

The speed range of the machine is in the neighborhood of 40 to 60 miles an hour, and splendid climbing ability has been shown. On many occasions three people have been lifted with ease, and the scores of passenger flights that Harry N. Atwood has already made with his aeroboat, as well as his splendid trips from Toledo to Detroit, have proved the worth of the new type.

An Early Slide Rule

David Baxandall, writing in *Nature*, says: "De Morgan, in article 'Slide Rule' in the *Penny Cyclopædia*, points out that though Gunter first used a logarithmic scale, the real inventor of the logarithmic slide was Oughtred. 'In the year 1630 he showed it to his pupil, William Forster, who obtained his consent to translate and publish his own description of the instrument, and rules for using it. This was done under the following title, "The Circles of Proportion and the Horizontal Instrument," London, 1632; followed in 1633, by an "Addition, etc.," with an appendix having title, "The Declaration of the two Rulers for Calculation."' After referring to a republication of this work in 1660, he goes on: 'The next writer whom we can find is Seth Partridge, in a "Description, etc., of the Double Scale of Proportion," London, 1685. He studiously conceals Oughtred's name; the rulers of the latter were separate, and made to keep together in sliding by the hand; perhaps Partridge considered the invention his own, in right of one ruler sliding between two others kept together by bits of brass.'

"Prof. F. Cajori, in his book, 'A History of the Logarithmic Slide Rule,' 1909, the result of an exhaustive inquiry into the literature of the subject, quotes De Morgan, and continues (p. 17), 'To Partridge we owe, then, the invention of the slide.' In an addendum (p. vi), he refers to a copy of Partridge's book in his own possession, published in 1662, in which it is stated that the book was written in 1657.

"Dr. Alexander Russell, in *Nature*, January 30th, 1910, p. 307, states: 'A few years before 1671, Seth Partridge rediscovered the sliding principle, perfected it, and gave an almost complete specification for the slide rule which is used to-day by engineers. . . . Personally, I consider that Seth Partridge is the real inventor of the modern 10-inch slide rule.'

"My object in writing is to direct attention to the fact that there is in the Science Museum at South Kensington a slide rule which is inscribed, 'Made by Robert Bissaker for T. W., 1654.' This proves that the slide was invented and *in use* three years before Partridge wrote his pamphlet, and eight years before the earliest known date of its publication.

"This very early example of the instrument is of boxwood, well made, and bound together with brass at the two ends. It is of the square type, a little more than 2 feet in length, and bears the logarithmic lines first described by Edmund Gunter. Of these, the *num.*, *sin.*, and *tan* lines are arranged in pairs, identical and contiguous, one line in each pair being on the fixed part, and the other on the slide. As Seth Partridge describes no feature which is not embodied in this example of the instrument, it would appear that less credit is due to him for invention in connection with the slide rule than has hitherto been given.

"In this year of the Napier tercentenary celebration it is interesting to know that a slide rule is still in existence which was made only forty years after the invention of logarithms."

A Long Rope Railway

A rope railway, 75 miles in length, is to be put in operation in India. It will connect the rich country in the Vale of Kashmir with the plains of the Punjab over the Himalayas. The line, it is claimed, will be the longest in the world, the present longest being 22 miles and situated in Argentina. Sections will be 5 miles long, and most of the spans will be 2,400 feet. The steel towers, some of which will be 100 feet high, will be braced, and double 1¼-inch cables, 9 feet apart, will carry the steel cars. The carrying capacity of these cars will be about 400 pounds.

View of two of the machinery halls at the exhibition.

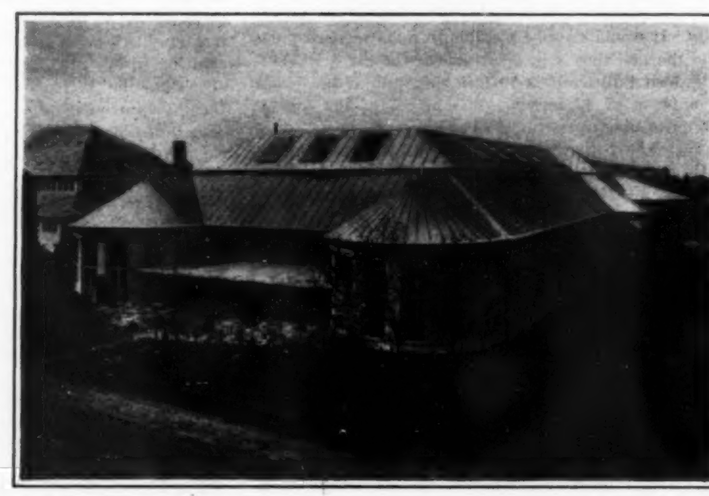
A World's Fair of Books

The International Exposition of Book Trade and the Graphic Arts at Leipzig, Germany

By Dr. Alfred Gradenwitz

On the very ground where, one hundred years ago, was waged the "nations' battle," a peaceful competition of peoples is taking place this year, for the benefit of civilization and the profit of mankind. The International Exposition of Book Trade and the Graphic Arts, at Leipzig, Germany, may fitly be called a symposium on human education; it unfolds before our eyes the history of culture, man's own history, giving an insight into the intellectual evolution of nations, the rise from darkness, superstition, and ignorance to light and joy, education, knowledge, and understanding.

No other city in the world could afford a more fitting and dignified frame for a world-fair such as this, than the ancient metropolis of the world's book trade, which in addition to its old traditions, boasts of a goodly number of important publishing firms and professional associations and schools. The idea of this exposition therefore awoke an enthusiastic echo in the population of Leipzig, and was greeted with joy by the profession, in Germany as well as abroad. It was soon realized that greater things than in the case of the average exposition were at stake, and the foremost experts, scientists, and artists willingly lent their assistance. The same appreciation was shown abroad, and no civilized country having achieved anything of importance in the field of book trade and the graphic arts was content to lag behind in the race.



A variety of architectural styles are represented on the exhibition grounds.

The "World's Fair of Books" coincides with the 150 years' jubilee of the Royal Academy of Graphic Arts and Book Trade of Leipzig, which year after year sends out so many artistically trained members of the profession.

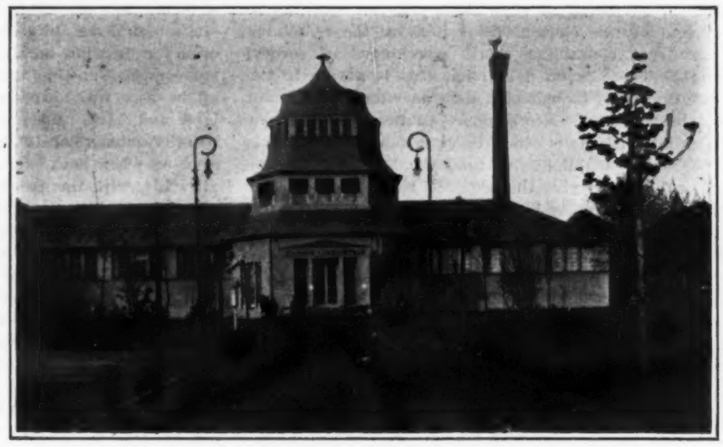
The spirit of the underlying idea finds a dignified expression in the architectural arrangement of the exposition. On entering by the main gate, leading to "October 18th Street," one obtains a splendid view of the exhibition grounds, while in the background the Leipzig Battle Monument looms up. To the right of this avenue, which is one of the main thoroughfares, traversing the whole length of the exposition, there is situated the extensive group of buildings constituting the German Main Hall, the heart, as it were, of the whole show. This hall covers an area of five acres, and comprises practically all branches of the printing and publishing industry.

The right-hand wing of the imposing building is given up entirely to the extensive field of German book trade and kindred industries, inclusive of the arts of repro-

The merchants' building.

The hall of civilization.

One of the exhibition pavilions.



The hall of paper industry.

duction, photography, and kinematography. We are shown, among other things, how the artist designs an alphabet, how the engraver copies it, and how the type is cast ready for the compositor. We may watch how the type and blocks are combined in the typesetting machines, to form the most varied typographic products; how the compositor's work is corrected and made ready for printing. The various modern printing processes in use are likewise exhibited.

In the central part of the building are housed, among other groups, those of bibliography, library, science, bibliophily, etc. The most beautiful products of German book-binding and the exhibits of the Imperial Printing Offices and German Patent Office are found there, in addition to the large Book Sales Exposition.

The whole left-hand wing and part of the rear of the building are taken up by a pantheon of the German publishing trade, where an adequate idea of the imposing number of books and musical editions brought out every year can be gained. The hall set apart for illustrated magazines is likewise found in this wing, and adjoining it is the Musical Editions' Sales Department, comprising a large hall for musical and literary recital.

On leaving the German Main Hall from the rear, we reach a square known as Gutenberg Square, on which are situated three huge engine halls, covering a total of 18,000 square meters. In the first engine hall a paper-making plant is shown in operation. In the second engine hall, printing, typesetting, and casting machines are similarly exhibited. The third engine hall shows, among other things, a large up-to-date book-binding shop, comprising about fifty auxiliary machines, in full operation. Foreign firms are largely represented in the first and second engine halls.

The intellectual center of the show is formed by the Hall of Civilization, on the left of Gutenberg Square, where the gradual development of the book trade and graphic arts with their forerunners in the various stages of civilization with all the peoples of history is shown in a comprehensive exhibit.

In three large annexes to the Hall of Civilization are housed two of the most important groups of the exposition, namely, the Departments of Graphic and Photographic Arts, respectively. The former comprises masterpieces of the contemporary graphic art of practically all civilized countries, and gives an excellent idea of what is being achieved at the present day in the field of etching, engraving on copper, artistic wood engraving, modern lithography, etc. Applied graphics, as exhibited in book-binding, artistic lettering, etc., is likewise represented, much room being devoted to book illustration. Photography as a free art is comprehensively represented in a huge hall, mainly as professional photography, though the amateur's art also finds a place. Nor are the very latest manifestations of the art, such as balloon and aeroplane photography, omitted. The scientific evolution of photographic art and its resources, as well as the latest advances, including the whole of kinematography and the manifold scientific uses of ordinary and moving-picture photography, are likewise on show.

"Nations' Street," a long avenue on which are situated the palaces of the nations participating on an especially large scale, leads from the Hall of Civilization to the second entrance to the exposition. On the right are seen the Italian and French buildings, two white pavilions designed in renaissance style. Between these, somewhat to the back, there is the huge hall housing a special international show, "The Business Man," where among other things, the evolution of commercial education, from its most primitive beginnings to its present perfection and variety, is illustrated. On the opposite side of the street is the Esperanto pavilion, a building devoted to "German Civilization Abroad," "German Colonies," etc., and finally, a pavilion where Japanese wood-cutters are demonstrating their art. On the right-hand side of this street is the Saxon State Building, where the Royal Academy of Graphic Arts and Book Trade, as well as the Bourse Association of German Booksellers, have some most excellent material on show; farther, the Austrian State Building, and between the two, in the background, a special exposition, "Picturesque Germany," where the choicest spots of the country are shown in photography. On the opposite side, beside the Wine Restaurant, there is the British Building, a structure designed in the Tudor style, and surmounted by a tin-crowned tower, an especially striking example of national architecture, and adjoining it, the Russian Building, the exact replica of the famous Moscow Kreml.

Opposite this Palace of Nations, there is the School Pavilion, comprising a hall for demonstrations and exhibits relating to the Boy and Girl Scout movement. In this pavilion is shown what a valuable help the book trade and graphic arts, in conjunction with the highly developed industry of educational appliances, are lending to the schools. An extensive group of buildings a little farther to the right then catches our eye. This is known as the "Industrial Town," and affords a fascinating picture of life and activity. The old Haynsburg Paper Mill here turns its wheels as 200 years ago, manufacturing hand-made paper in accordance with the methods of the time. A historical hand-printing plant is also installed where the type is cast and composed by hand. Side by side with these old, primitive shops are exhibited examples of the most advanced modern art, including a modern paper machine, which has a capacity equal to that of 500 hand-workers. In large halls housing the exhibits of the Association of German Paper Makers, visitors are shown the raw materials employed in paper manufacture, how these are worked into the various kinds of paper, and how manifold objects are manufactured from this material. This group of buildings terminates at the Newspaper Printing Office, where two huge rotary machines serve to demonstrate modern newspaper printing, while a third one illustrates in a most striking manner the most recent engraving process, rotogravure. The genesis of a newspaper is illustrated from the reporter's manuscript to the printed and folded copies. The historical development of journalism is also set forth, from the most primitive beginnings—fire signals and mounted messengers—up to the splendid achievements of modern engineering, wireless telegraphy, and telephotography.

On the left we reach a spacious pavilion housing a special show, "Woman in the Book Trade and Graphic Arts," where a comprehensive idea can be gained of the work done by women in all branches of printing, literature, music, the decorative art, library management, etc. Opposite this rises the hall where the Exposition of Trade Journalism and the special show of Stenography are installed. The latter demonstrates the whole evolution of shorthand from antiquity to the present day, with its manifold systems, and affords a practically complete picture of the highly developed shorthand industry.

Close to the other side of the main entrance, there are three auditoriums, holding 300, 600, and 1,200 people, respectively, and the moving-picture theater of the exposition. This part of the exposition grounds also comprises a number of cafés, restaurants, and places of amusement. Beyond the bridge there is a miniature German college town or *quartier latin*, illustrating the typical life of German undergraduates.

Light Alloys for Automobile Parts

Not many years ago one of the troubles of the manager of a big engineering works was the importunity of the purveyors of perfect lubricants. Though we still have these with us, the oil merchant has a serious rival in the man who claims to have invented a perfect aluminium alloy. Of these alloys there are some hundreds known by name, if not as a result of actual experience, and this number is being added to almost in inverse ratio as the cost of aluminium, owing to improved electrical methods, is reduced. Practically speaking, very few of the light aluminium alloys that have been produced with a view to revolutionizing engineering constructional methods have been a success from the industrial standpoint. The reason for this, as has been pointed out by Law, is to be found in the fact that aluminium unites with most of the common metals to form definite chemical compounds which crystallize out in a matrix of practically pure aluminium, and it is known that alloys with conglomerate structures of this description are only useful in special cases. Such compounds are formed with iron and copper, nickel, antimony, manganese, and tin.

ALLOY FOR MOTORCAR PARTS.

Zinc, on the other hand, forms what are known as solid solutions with aluminium, and the alloys of these metals, either alone, or more often with small additions of other metals, such as copper or magnesium, are practically the only ones of industrial importance. Alloys of aluminium and zinc have been very fully studied by various investigators, and are largely used in the motor industry for castings of crank-cases, gear-boxes, etc., the proportion of aluminium being, approximately, 88 per cent, that of zinc 10 per cent, the balance being made up of copper. Such an alloy has a tensile strength of from eight to ten tons per square inch. Though this particular alloy is stable, many aluminium-zinc alloys are liable to failure through aging, a process which can be prevented, however, by the addition of certain elements, which in many cases are claimed to give alloys very remarkable properties. What these elements are is not always perfectly clear, for though inventors often take the trouble to patent certain mixtures, and thereby tell the world what metals are supposed to enter into their alloys, it does not necessarily follow that all these metals are invariably used, or if used will be found to be present in the alloys on analysis.

Among the metals that are frequently added in small quantities to aluminium to produce special alloys may be mentioned nickel, manganese, silicon, iron, sodium, potassium, chromium, tungsten, titanium, mercury, and magnesium. The latter element was alloyed with aluminium the first time nearly forty years ago, and forms the basis of the well-known alloy, magnalium, which, unlike unsuccessful early magnesium alloys that contained as much as 10 per cent of the metal magnesium, now contains only something in the order of 1.6 per cent of magnesium, the resulting alloy being a much superior product, particularly when alloyed with about 1 per cent each of copper and nickel.

AN ALUMINIUM ENGINE.

In fact, it has been suggested in a paper read before the American Society of Automobile Engineers that the use of magnalium for the cylinders and pistons of internal combustion engines is a practical possibility, and here we may remark that we know of the existence in London of a small working internal combustion engine that is made entirely of alloy aluminium with the exception of the crankshaft and the flywheel. Besides the aluminium-manganese and aluminium-zinc alloys, there are many other binary alloys, including the aluminium-copper series and the aluminium-nickel series, but at the present time the tendency is undoubtedly toward the to be evolved more complex alloys

made up primarily of aluminium, often as much as 95 per cent of this element being present, the remaining 5 per cent containing small percentages of several metals. There is no doubt that this is a step in the right direction, though obviously an enormous amount of experimenting has to be done—particularly when one is dealing with, as is often the case, four or five metals in addition to aluminium—to determine the best possible mixture to give the required results, and in this connection there may be mentioned a new complex alloy known as miralite, which appears to be suitable for many kinds of engineering work.

WIRE DRAWING.

This alloy, which consists mainly of aluminium and nickel in proportions, respectively, of 95 per cent and 4 per cent, with the addition of certain other rarer elements, has proved to possess excellent casting properties and to be suitable for rolling and spinning, and even for drawing into very fine wire. As showing its non-corrosive and untarnishable qualities, a large sheet of the alloy was towed behind a steamship to New Zealand and back, and proved on examination after six months' submersion in the sea to be as clean in appearance as when new. It appears to resist the action of all acids, with the exception of hydrochloric, which no aluminium alloy that has ever been made, or in all scientific probability ever can be made, will withstand. The alloy, it is claimed, does not disintegrate even after considerable friction and shock, as is proved by the fact that a complete railway carriage equipped with alloy furniture and fittings, after more than twelve months' continual use, and notwithstanding great vibration, is still perfect in every particular. The tensile strength of a sample of the alloy has been shown to be 12 to 14 tons to the square inch, or 17 tons in 18-gage wire. Its specific gravity is 2.62, which compares with 2.56 for cast aluminium and 8.6 for cast copper, so that it would appear to be nearly equal to aluminium in this respect, while much lighter than brass or German silver.

At present approximately 15 per cent of the aluminium output of the world is used for electrical purposes, and 65 per cent is used in the motor industry, leaving only 20 per cent for other purposes. It should be quite possible for the proportion as regards other purposes to be considerably increased now that what appear to be generally satisfactory, though complex, alloys are being produced which have almost unlimited applications.—*The Daily Telegraph* (London).

Some Characteristics of Antivivisection Literature*

Who are the Authors Quoted as Authorities by Antivivisectionists?

By Walter B. Cannon, A.M., M.D.

SOME time ago I obtained from the four chief antivivisection societies of the country[1] copies of the pamphlets and leaflets which they distribute widely to school teachers and clergymen and other influential but medically uninstructed persons. For about two years I have also collected letters and articles which have been published on the subject in the daily press and in magazines. This literature can be considered with reference either to the justice of its claims, or to the fairness of its methods. For the present I wish to hold a consideration of the merits of the controversy in a secondary position and to examine these accumulated writings as to some of the tactics which they display.

To go through this matter with patience is a difficult task. Dreary iteration of the same opinions, the same "eminent authorities," the same tales, characterizes the society publications; and these publications, sent broadcast, are used again and again for texts, examples and references by contributors to newspapers and journals. Surely this is vain repetition, for any one whose intelligence is not stupefied with weariness can perceive that if the identical names and phrases and the identical instances have to be continuously cited, the cause must be short of both men and ammunition.

One of the most impressive exhibits which the antivivisectionists make is the list of physicians whose opinions they quote. This list is worth examining with some care. In doing so we should keep in mind that the great victories of experimental medicine have come since 1850, and in largest number since 1880; and furthermore, that this illustrious period of medical history is practically coincident with the use of anesthesia, not only in surgery, but in experimentation as well.

Many of the physicians whose opinions are quoted are dead. Some died long ago, others who have passed away more recently received their formal education in medicine before the period I have just mentioned. Of all the names cited the most renowned is that of Sir Charles Bell, born in 1774 and dead some 70 years, known for his discovery of the distinct functions of the dorsal and ventral roots of spinal nerves, and for his study of the functions of the fifth and seventh cranial nerves. In each of these important investigations his final proof was secured through experiments on animals. His own description of his greatest discovery is as follows: "On laying bare the roots of spinal nerves I found that I could cut across the posterior fasciculus of a nerve which took its origin from the posterior portion of the spinal marrow without convulsing the muscles of the back, but that, on touching the anterior fasciculus with the point of a knife, the muscles of the back were immediately convulsed."[2] On this experiment, done a hundred years ago, nearly forty years before the use of general anesthesia, his fame rests. To quote him to-day as opposed to the use of the experimental method is, under the circumstances, not only a contradiction of his own practice, but a gross anachronism.

Another name which, like the words of Humpty Dumpty, ought to be paid extra because so much overworked, is that of Henry J. Bigelow. He was born 92 years ago, and has been dead for 23 years. The address so often quoted was delivered in 1871—back four decades. According to the testimony of his colleagues in the Harvard Medical School, his views on vivisection were apparently based on what he had seen at the veterinary school at Alfort, France, in the pre-anesthesia days, and he had not controlled these early impressions by any experience in a modern laboratory. A close associate has testified that during the last years of Dr. Bigelow's life he never heard him say a word against animal experimentation.[3] Furthermore, in a letter which has been little noticed Dr. Bigelow objected sharply to the lack of discrimination among antivivisectionists. "The confounding of a painful vivisection," he wrote, "and an experiment which does not cause pain, either because the animal is under ether, or because the experiment itself is painless, like those pertaining to the action of most drugs, or because it is a trivial one and gives little suffering, has done great damage to the cause of humanity."[4] And yet Dr. Bigelow is continually cited as a famous surgeon who was opposed to experiments on animals.

One other medical name appearing again and again in antivivisection writings is Lawson Tait (born 1845, died 1899). He has been described by a competent and trustworthy surgeon as a "man of wild statements."[5] Certainly that characterization is justified by Tait's promise that if he could get enough disease germs he would gladly use them as dressings for surgical wounds, and also by his absurd denunciation of Koch, Pasteur and Lister, the leaders of modern medicine, as men who had "not only hindered true progress, but covered the profession with ridicule." This extraordinary attitude, together with his opposition to the use of animals for medical research, is perhaps explained by a line in the sketch of his life: "He enjoyed being in a minority, and this led him to champion many lost causes."[6]

Other physicians whose opinions are quoted are of less note. There is Dr. Charles Clay, born in 1801, "interested in geology and archeology and collector of fossils." There is Dr. Charles Spooner, born in 1806, veterinary surgeon. There is Dr. John Elliotson, born in 1791, who alarmed his colleagues by administering extravagantly large doses of supposedly poisonous medicines; also mesmerist, and founder of a mesmeric hospital. There is Dr. J. E. Garretson born 86 years ago, and Dr. Elizabeth Blackwell, born 93 years ago. There is Sir William Fergusson, M.D., born more than a century since, said to be ill-advised in some expressions of opinion, "especially in matters requiring more knowledge of physiology and hygiene than he possessed" There is Charles Bell-Taylor (died in 1909, aged 80), who originated the widely quoted sentence, "Pasteur does not cure hydrophobia, he gives it;" and who, ignoring our great debt to animals for the medicines that induce sleep, for all those that give us local freedom from pain, for physostigmin, amyl nitrite, epinephrin, and many others, told his antivivisection admirers that experiments on animals have yielded us no knowledge of drugs. There is Sir Richard Owen, M.D., comparative anatomist and zoologist, born in 1804. There is Dr. John Abernethy, who died in 1831. There is Dr. J. J. Garth Wilkinson, born a century past, holder of an honorary M.D. degree, poet, mystic, expositor and editor of Swedenborg, author of "Improvisations of the Spirit," "Isis and Osiris in the Book of Respiration."[7]

In antivivisection literature the opinions of these persons are presented with no reference to the time when they were living and with no indication of the interests other than medical which filled their lives. The ingenuous reader takes his cue from the words of the pamphlet that they are "men of the greatest eminence among the vast number of physicians and surgeons who have opposed vivisection," and wonders how doctors can so profoundly disagree.

Among the living medical men quoted by the antivivisectionists, Sir Frederick Treves is most prominent. In 1898, he stated incidentally that some experiments which he had performed on the intestine of the dog had done little but unfit him to deal with the human intestine. This was, of course, merely his personal experience, and can readily be offset by that of other experienced surgeons who testify to the exact opposite. Indeed, there is probably no field of surgical manipulation that has benefited more by animal experiments than that of the gastro-intestinal tract. Sir Frederick was quick to point out the false implication placed on his remarks.

"Those who are familiar with the controversial methods of the antivivisection party," he wrote, "will not be surprised that certain of my remarks have been cunningly isolated from the context, and have been used in advertisements, pamphlets, and speeches, to condemn all vivisection experiments as useless. The fallacy of vivisection can hardly be said to be established by the failure of a solitary series of operations dealing with one small branch of practical surgery. No one is more keenly aware than I am of the great benefits conferred on suffering humanity by certain researches carried out by means of vivisection."[8]

That was written more than eleven years ago, yet Treves still continues to be quoted as another of the eminent surgeons who have opposed vivisection.

What I have been able to learn about the other living "physicians and surgeons of greatest eminence," quoted as hostile to experiments on animals, has come mainly from the publication, "Who's Who." Since the notices in this volume are little autobiographies, I should not be accused of employing the last resort of a losing advocate, the abuse of the opposing counsel, if I quote what these persons say about themselves. Dr. Arabella Kenealy sets herself down as novelist and contributor to magazines, author of "Molly and Her Man of War," "Some Men are Such Gentlemen," and other volumes. Dr. W. Gordon-Stables describes himself as novelist, journalist, professional writer for 24 years, author of 136 books with serial novels; "In the Dashing Days of Old" and "The Pirates' Gold" are cited as examples. Dr. W. R. Hadwen, secretary of the British Union for the Abolition of Vivisection, public advocate of the repeal of the Vaccination Acts and the prohibition of experiments on animals, is engaged in reform movements relating to temperance, food, hygiene, sanitation, education, and burial laws; he finds his recreation in changing his occupation. Dr. Edward Berdoe, born 77 years ago, reports himself as a writer; author of Browning studies, "Browning and the Christian Faith," "A Browning Primer," "The Browning Encyclopedia," "The Biographical and Historical Notes to Browning's Complete Works," and several other books; also editor of the "Zoophilist." Dr. Josiah Oldfield, a lawyer, and senior physician to the Lady Margaret Fruitarian Hospital, strong advocate of the fruitarian diet; author of "Flesh Eating as a Cause of Consumption," "Butchery and Its Horrors," and other volumes. Dr. J. D. Buck, 72 years old, president of the Theosophical Society of

* Pamphlet xix, issued by the Council on Defense of Medical Research of the American Medical Association, republished by permission of the Association.

[1] The New England (Boston), the New York (New York city), the American (Philadelphia), and the Vivisection Reform Society (Chicago).

[2] A New Idea of the Anatomy of the Brain, London, 1811.

[3] Animal Experimentation, Boston, 1902, pp. 48, 74.

[4] Anesthesia: Addresses and Other Papers, Boston, 1900, p. 371.

[5] Animal Experimentation, Boston, 1900, p. 47.

[6] Dictionary of National Biography.

[7] The data given above were found in the Dictionary of National Biography.

[8] The *Times*, London, April 18th, 1902.

Ohio, author of "Nature and Aims of Theosophy," "Mystic Masonry," "Why I Am a Theosophist." Dr. Stephen Townsend, novelist, surgeon, and actor, on the stage for years, playing prominent rôles in "Sowing the Wind," "Slaves of the Ring," "Black Tulip," and others. This completes the list of "eminent" physicians and surgeons who have opposed vivisection, concerning whom I have been able to find any characterization whatever, the rest are not of sufficient importance to be mentioned in any of the dictionaries or cyclopedias of biography that I have searched through for information. And this is the array of medical experts who have denounced the method of investigation which, according to Osler, "did more in the half-century between 1850 and 1900, to emancipate medicine from the routine and thraldom of authority than all the work of all the physicians from the days of Hippocrates to Jenner."

I do not wish to imply that unless a physician does nothing but practise medicine his opinions on medical matters are of little value. But when a person with a medical degree denounces the antitoxin treatment of diphtheria, I am interested to learn that the time of that person is spent in composing romances. When another declares that the cruelty of experimentalism is "horrible to contemplate," I am better able to value his words when I know that instead of "contemplating," he has for 24 years been industriously writing and has now to his credit nearly seven-score volumes. A third expert who declares experiments on animals useless and unscientific, I understand better when I find that he is a professional agitator, working for the abolition of vivisection and for the destruction of community barriers against small-pox. The sounding phrases, "Pasteurian quackery," "antitoxin nostrum," "vivisection founded on cruelty, supported by falsehood, and practised for selfish ends," have less significance when I realize that they are the expression of an aged man who has devoted his life to studying, annotating, and editing Browning's poetry. Again, in reading the grotesque exuberance of the fruitarian lawyer, that "vivisection takes no note of pain; its spirit is not healing, but killing; its object is not to relieve pain in the victim, but to cause it"—I wonder in precisely what way fruitarianism and the law have given him intimate acquaintance with the subject he so roundly denounces. And finally, when the theosophic propagandist, past his threescore years and ten, unites with the actor-novelist-playwright in declaring that "scientifically" experiments on animals are useless, I have a basis for seriously suspecting that they are not trained to judge these matters scientifically.

If now we examine this list, we find that it is made up of persons long-since quick, or long-since dead, persons who have not been opposed to vivisection in any unqualified sense, persons whose eminence in literature and art was the only eminence they possessed, and persons so obscure as not to be noticed in any manner whatever, except in the pages of an antivivisection leaflet. When we consider that every advance in medicine, like every advance in other realms, has suddenly revealed the reactionaries, the great marvel is that there are not medical men of real prominence who will support the antivivisection cause. But if "among the vast number of physicians and surgeons who have opposed vivisection," those we have just investigated are "of greatest eminence," surely the professional endorsement is insignificant.

Demonstration that many of their experts have no respectable qualifications for testifying will not, I believe, cause the antivivisectionists to withdraw either the names or the opinions of these men from circulation. Sir Frederick Treves called attention to their adroit misuse of his remarks more than eleven years ago. Instead of respecting his expression of direct disapproval of their cause they have continued classifying him as an opponent of vivisection. The ignoring of Treves's correction is a thoroughly characteristic maneuver on the part of the agitators. Other examples are numerous. Commenting on an experiment by Dr. H. P. Bowditch, in which the peripheral end of a nerve, which had been severed under ether, was stimulated, Mr. P. C. Peabody stated: "It will be readily seen, even by the casual reader, that it involves an amount of agony beyond which science is unable to go and to approximate to which is impossible except by a person who has devoted long years to the study of nerves." Eighteen years have passed since Dr. Bowditch plainly pointed out the utter absurdity of the assumption that even the slightest pain could have been inflicted by stimulating a piece of nerve separated from the central nervous system,[9] and yet the New England Antivivisection Society was recently still distributing this ancient slander.

Thirteen years ago Dr. W. W. Keen,[10] in a paper of admirable simplicity and directness, laid bare instances of repeated interpolations, mistranslations, and garbled, inaccurate accounts of experiments in a single antivivisection publication. What was the effect? To what degree have 13 years been sufficient for the development, in antivivisectionists, of respect for the facts?

In a pamphlet now being circulated I find mentioned Dr. Berkley's observations on the effects of administering thyroid extract to insane patients. Although Dr. Keen showed that the therapeutic use of thyroid extract varies between 15 and 60 grains per diem, and that Dr. Berkley's maximum dose was only 15 grains per diem, the pamphlet does not distinguish between the toxic effects of these small doses in some cases and the beneficial effect in others, but declares that Dr. Bérkley was "poisoning" his patients. It goes on to state: "Two patients became frenzied, and of these one died before the excitement had subsided." In the original the sentence is completed by the words, "the immediate cause of the exitus being an acute disseminated tuberculosis." The absurdity of attributing death by galloping consumption to thyroid tablets, which had not been given anyhow for seven weeks, was clearly explained by Dr. Keen more than a decade ago. He did not emphasize the wrong done to Dr. Berkley by the crafty mutilation of a sentence. Of course, a decent sense of honor would have impelled an instant correction of this wrong, yet the antivivisectionists have continued these 13 years to deceive the credulous public without any moving consideration that their imposture involved a man's good name.

Another statement in the pamphlet is as follows: "Dr. A. H. Wentworth, senior assistant physician to 'The Infants' Hospital,' Boston, made forty-five vivisections, tapping the spinal canals of children, many of whom died." Unless the writer of this statement intended to intimate that there was a connection between the death of the children and the tapping of the spinal canal, the statement is without significance in an antivivisection publication. A careful reading of Dr. Wentworth's paper shows that the tapping of the canal, which is now (though it was not then) a common routine procedure, had no harmful effects whatever. To be sure, *some* of the children died later, but in every fatal instance the cause of death, which had no relation to the operation, was definitely determined and stated. All these facts Dr. Keen pointed out 13 years ago. What was the result? The story with its evil insinuation is still circulated everywhere by the antivivisectionists, again without any observable respect for the facts, or regard for an honorable reputation. Even this exhibition of hostility has not proved a sufficient outlet for antivivisection feeling, for in the *Journal of Zoophily*, April, 1910, p. 44, Dr. Wentworth is referred to as having experimented "on between forty and fifty little children in the 'Children's Hospital' of that city (Boston) *every one of whom died* after the performance of his operation."

Six years have passed since the attention of officers of the New York Antivivisection Society was called to the fact that by suppressing mention of anesthetics in experiments they described, they were giving a wholly false impression of the way in which these experiments were conducted. Again, several years ago, Dr. F. S. Lee indicated in a public letter[11] that the society, in spite of having had a full year in which to correct these misrepresentations, was intent on its policy of deluding the public. I have recently had occasion to examine again the pamphlets which the society is distributing; the misrepresentations were still there, unchanged.[12] Details of operations by Dr. W. S. Halsted are quoted, and although the original account expressly stated that anesthetics were employed, the pamphlet does not even suggest them. Selections taken here and there from Dr. G. W. Crile's report of his experiments on surgical shock are presented, again with no intimation of anesthesia; and this in spite of Dr. Crile's printed statement that "in all cases the animals were anesthetized," and also in spite of the testimony of Dr. F. W. Goodbody[13] and of Sir Victor Horsley[14] (in whose laboratory, under the English antivivisection law, much of the work was done) that the animals, though sometimes exhibiting reflexes, were completely insensible to pain.

The society furthermore continues to suggest that one can only imagine "how intense the suffering," which caused a cat at the Rockefeller Institute to "spend the day jumping on and off the furniture," when in fact, as Dr. Carrel explained 5 years ago, the animal was a young cat, in perfectly normal health, manifesting its natural playfulness.

From these specimens of persistent disregard of fair treatment, when can we expect that mis-statements and evasions, even if publicly exposed, will be withdrawn? Two years are evidently not enough for the antivivisectionists to manifest this sense of honor, nor are ten years, nor fifteen. I have cited instances in their literature, instances of grossly garbled descriptions of the work of medical men, the inaccuracies in which have been clearly demonstrated for these long intervals, without, however, any sign of a tendency on the part of the prevaricators to reconstruct their statements in conformity with the facts. Experience has proved that the false story once well told, need not be withdrawn or altered, even if its falsity has been exposed, for that part of the public that likes to be humbugged is ready to read and listen and yield its humble credence.

The fundamental wrong committed by the antivivisectionists in their agitation against medical research is the presentation of a misleading issue. They deny that any utility has come from animal experimentation, they describe the experiments as horrible torturing of dumb brutes, and then they ask if this futile cruelty shall be permitted to go on. If this really were the whole story, few would hesitate on which side to stand. Every decent man and woman is opposed to cruelty; every decent human being winces at the thought of inflicted pain. It is for this reason that the picture of the fastened dog makes such a powerful appeal. But this is not the whole story. As I have pointed out elsewhere, it would be as fair to display a picture of Grenfell fighting his faithful dogs and stabbing them to death, labeled "Is this the way to treat your pets?" as it is to represent animal experimentation without its motives and without its triumphs. Grenfell, in his struggle on the ice-pan, stabbed his dogs[15] to save his own life, and every man with common sense commends the bravery, the resourcefulness and the proper sense of values of this missionary hero. That is what any worthy man who sees straight would try to do if he were cornered and had to spend his own life or that of lower animals. Precisely that is the issue which the investigators see. And they know also that by the sacrifice of some animals the chance of life and health for mankind and for myriads of other animals as well, has been enormously enlarged. Read the articles, written recently by experts in the several fields, telling the relation of animal experimentation to the treatment of diphtheria and tetanus, to meningitis, rabies, small-pox, to dysentery and cholera and typhoid fever, to plagues, tuberculosis, syphilis, to the disturbances of internal secretions, to our knowledge of the action of drugs, to surgical technic, to childbirth, to hygiene and preventive medicine—read these articles[16] and learn what the animals have done for their fellow creatures. Just because they have rendered such immeasurable service do we turn to them for further aid. Of the animal thus used Prof. William James has written with illuminating insight: "If his poor, benighted mind could only be made to catch a glimpse of the human intentions, all that is heroic in him would religiously acquiesce."[17]

Before the antivivisectionists can command the respectful attention of intelligent people they must fundamentally change their tactics. They must clear their literature of the anachronistic hostility of men long since dead, men who had no conception of the merciful procedures of modern experimentation, nor of its life-giving results. They must rid their publications of the testimony of spurious experts whose reputations were made in literature, art or theology, and not in the service of healing. They must purge their propaganda of the fraud and trickery and evil insinuation that have for years characterized it. And I may perhaps be permitted to suggest that the process of making their methods clean and their ways straight involves paying some respect to the high purpose of biologic investigation and its beneficent achievements for human welfare, which together give meaning and sanction to the experimental use of animals.

The Explosion of a Balloon.—The explosion of a spherical balloon is an accident which is fortunately of rare occurrence. Much damage was caused by the explosion of the balloon belonging to the well-known aeronaut Leprince at Epernay, France. Starting on a flight at 5 o'clock P. M., from a public square, a gust of wind drove it against a tree, causing a rent in the balloon, and it then exploded, possibly from the presence of a smoker in the crowd. No less than 25 persons were wounded by the explosion, including the aeronaut, he no doubt fatally.

[9] Communications of the Massachusetts Medical Society, 1896, p. 43.

[10] The *Journal* A. M. A., February 23rd, 1901.

[11] New York *Evening Sun*, March 12th, 1909.

[12] These publications, which contain also the statements about Dr. Wentworth and Dr. Berkley above mentioned, were sent to a friend of mine in November, 1910, with a letter from the president of the New York Antivivisection Society proclaiming, with reference to the pamphlets: "You may rely on them as being absolutely accurate and authentic."

[13] London *Times*, March 13th, 1902.

[14] Minutes of Evidence, English Royal Commission on Vivisection, 1906-08, Questions 15893-7, 16220-2.

[15] Grenfell, Wilfred T.: A Voyage on a Pan of Ice, Boston, 1908.

[16] Published by the American Medical Association, Chicago.

[17] The Will to Believe and Other Essays, New York, 1899, p. 58.

Controlling Ships' Engines Directly from the Bridge

Mechanism Which Places the Control into the Captain's Hand

No doubt the greatest divergence from accepted marine standard and practice in the original installation in the "Neptune,"[1] was in the method of control of the turbines, they being under the control of the navigator on the bridge, as well as from the starting platform. To marine engineers and navigators, such an innovation probably appeared unnecessary and fantastic, and too great a step aside from the trodden path to be safely employed; and that such feeling existed, and probably still exists in the minds of some engineers, is shown by the hostile criticism of the bridge control.

However, after the trials of the "Neptune" and months of service, the bridge control has shown itself to be absolutely reliable, and after becoming accustomed to it, those having experience with it have come to use it in preference to the ordinary engine room telegraph which was, of course, a part of the "Neptune's" equipment.

During the service of the "Neptune," a number of occasions arose in which the advantages of the bridge control were shown in a very striking manner. This is brought out in the report of Lieut. W. W. Smith, U. S. N., who was in charge of the "Neptune's" machinery, and from which we quote as follows:

"The bridge station has been used in steaming, in going alongside ships, and in docking. While steaming it requires practically no attention, as the regulation is automatic. The speed has been regulated accurately, but not as accurately as desired. Unfortunately there has been no opportunity for steaming in formation, but I have no doubt of the suitability of the control system for this purpose. In maneuvering, in coming to anchor, going alongside, etc., the regular bridge detail has handled the turbines without difficulty. In this connection, attention is invited to the fact that none of the deck officers are experienced in engineering. In fact, they have no knowledge of it. If men of this type can use the bridge control, there should be no difficulty on a naval vessel. In maneuvering, the control gear has operated satisfactorily. The indicators show the operator what the turbines are set to do, and what they are doing. Gages show the air and steam pressure available. The gages and indicators have special dials so that the indications can be understood by an untrained man. With this control gear, it is as easy for one man to operate the engines of a battleship as it is to run an automobile.

"Under service conditions, there is a saving in time in operating from the bridge of from 2 to 6 seconds, which depends principally on the engine-room operator. Under test conditions, of course, this would be less. To the officer on the bridge, it gives confidence to know that the propellers are entirely under his control, that the control gear operates quickly and exactly the same each time. There is no doubt as to whether the signal is being answered properly and promptly. There is no one over whom he has no control to use discretion to keep the steam up when the ship is in a dangerous position. In case of emergency, the officer on the bridge can best decide whether it is best to save steam or avert a collision.

"In two instances it was necessary to increase the speed suddenly to avoid collision. The steam pressure dropped very low and some of the auxiliaries were about to stop. The engineer protested vigorously against such unwise operation. He, not knowing the danger, would probably have eased up to save steam, and collision would have resulted.

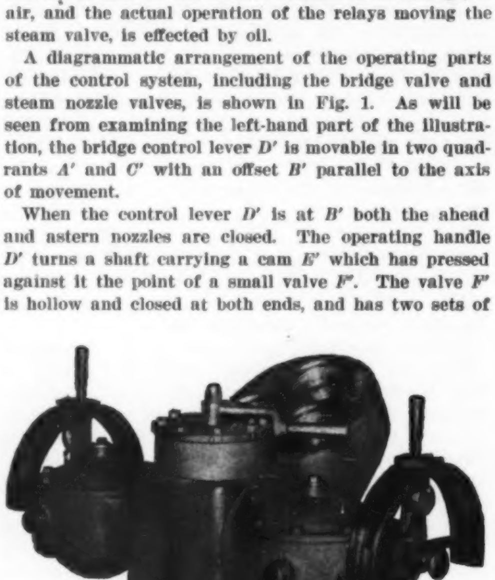
"During one voyage the propellers came out of water so that excessive racing would have occurred with ordinary machinery. Most of the time they came half way out, and frequently they came practically all the way out. Owing to the action of the governing mechanism, racing was prevented. The speed increased and decreased slightly—about 4 per cent estimated. The turbine inlet valves were opening and closing continuously, and at times they were entirely closed. Quick-operating valves are necessary to effectively prevent racing. This feature of the control system is of importance because it will enable a vessel to steam at considerable speed in heavy weather.

"After being modified, the control system has been thoroughly reliable. Even if the bridge control should fail, it only requires a few seconds to change to the engine room. This feature has been frequently tested and found satisfactory. However, with the improvements which will be made in accordance with the experience gained with this, the first installation, I am convinced that operation from the bridge will be absolutely positive and reliable under all conditions. In my opinion, it will be more reliable than the telegraph, although the latter is good in this respect. As the general principles are the same, there is no reason why it should not be as reliable as the air brake, or even more so, as the service is less severe."

The medium used for transmitting to the engine room the movements of the control handle on the bridge, is air, and the actual operation of the relays moving the steam valve, is effected by oil.

A diagrammatic arrangement of the operating parts of the control system, including the bridge valve and steam nozzle valves, is shown in Fig. 1. As will be seen from examining the left-hand part of the illustration, the bridge control lever D' is movable in two quadrants A' and C' with an offset B' parallel to the axis of movement.

When the control lever D' is at B' both the ahead and astern nozzles are closed. The operating handle D' turns a shaft carrying a cam E' which has pressed against it the point of a small valve F'. The valve F' is hollow and closed at both ends, and has two sets of



Bridge control stand.

ports, G' and H', the former always being in communication with the source of high pressure air supply (furnished by a standard Westinghouse air brake compressor), and the latter having its edge to the extreme left, just line in line with the ports I' in the piston L'. The end of the plunger valve F' is line in line with left-hand edge of the ports I'. A small spring K' within the piston L' is provided to maintain a positive contact between the point of the plunger F' and the cam E', thus fixing the position of the plunger F' by its point of contact with the cam E'. The movement of the piston L' to the left is resisted by the spring N'. The space J' to the right of the piston L' communicates with space Q' between two diaphragms R' R' and the space to the left of the piston L' communicates with the atmosphere. A communication to the passage within the piston L' to atmosphere is provided by the ports M'.

The diaphragms R' R' control two valves T' and U', the former controlling an opening to atmosphere, and the latter an opening to the source of high pressure air supply. The spaces S' S' are connected by a passage, so that the pressure in them is always equal. The space S' communicates either with the ahead or the astern operating relay in the engine room.

The function of the bridge control valve just described is simply to maintain a predetermined constant pressure in the air relay chamber, and this is accomplished as follows, with the apparatus just described.

When the lever D' is moved from its central position, B' in the ahead quadrant A', the cam E' pushes the valve F' to the left, thereby bringing the port H' into communication with the port I' in the piston L'. This admits high pressure air into the space J', and consequently Q'. As the pressure in the space J' increases, it will quickly force the piston L' to the left, until the right hand edge of the post I' cuts off communication with the port H', or should there be leakage, it will take a position such that the opening through the ports H' and I' would be just large enough to pass sufficient air to make up for the leakage and maintain a constant pressure in the space J'.

Since normally the spaces S' S' are at atmospheric pressure, when the pressure between them in the space Q' is increased, the diaphragms are forced outward, closing the valve T' and opening the valve U', thus admitting high pressure into the space S' S' until the pressure in the latter is equalized with the pressure in the space Q', thus bringing the diaphragms back to their normal position, permitting the valve U' to seat and thus cut off the supply of high pressure air. The pressure existing in the space S' is transmitted to the space P to the left of the air relay chamber in the engine room.

As in the case with the piston L' and the ports I' and H', should there be leakage in the piping system communicating with the space S', the diaphragms R' R' will be distended slightly, thus holding the valve U' open sufficiently to make up the leakage and maintain constant pressure. Conversely, it is evident that if the pressure in the space J' should increase above that predetermined for a given position of the piston F', the piston L' will move to the left, and open communication between the space J' and the inside of the piston L', thus exhausting air from the space J' to atmosphere through the port M'. This condition also arises when operating lever D' is moved toward the off or central position, which permits the movement of the valve F' to the right. In the latter case the pressure in the space Q' will be decreased and become less than the pressure in the spaces S' S', causing the diaphragms R' R' to collapse and open the valve T' to atmosphere until the pressure in the spaces S' S' is decreased to that in the space Q'.

When the control lever D' is to be moved to the astern position, it is necessary to move it in the direction of its axis of rotation in the slot B'. When this is done, and arm W', held between two collars on the cam shaft, moves the small slide valve X' to the right, and brings the pipe Z' to the astern air relay cylinder into communication with space S', and the pipe Z'' into communication with the atmospheric exhaust.

From the above it will be seen that it is impossible for the operator to become confused and accidentally move the control lever in the wrong direction, or try to put it in both the ahead and astern position at the same time, as it is necessary to move the controlling lever sideways before it can be moved from one position to the other.

The governor, which controls the speed of rotation of the turbine shaft, is shown on the right of the diagrammatic sketch, Fig. 1. As will be seen, it is of the common fly-ball type, and is driven through the turbine shaft by a worm E and wheel D. The only movable part of the governor is the hollow spindle B, having the ports N and H in it. The movement of the spindle B is restricted by a diaphragm K to which it is attached. The upper side of the diaphragm is open to atmosphere, and the space below G is filled with oil.

High pressure oil at about 65 pounds gage per square inch is admitted to the revolving spindle B through the ports A.

When the governor spindle is revolved by the turbine shaft, the balls M M are thrown outward by centrifugal force, thus pulling the spindle B downward against the resistance of the diaphragm K, opening communication through the port H in the spindle, and I in the upper spindle bushing, to the space G, the latter communicating through a port L to a pipe connected to the space N of the air cylinder relay.

As the pressure in the space G, below the diaphragm K, increases, it resists the downward thrust of the spindle B, due to the centrifugal action on the governor weights until the upward pressure on the diaphragm exactly balances the downward thrust of the spindle, thus permitting the upward movement of the spindle B by the elasticity of the diaphragm K until the communication through the ports H and I is cut off. Thus it is evident that for any given number of revolutions of the governor spindle, there must be a constant fixed pressure of equilibrium in the space G below the diaphragm. Should the pressure in the space G exceed that corresponding to the speed of rotation of the governor at any instant, the spindle B will be forced up-

[1] For an account of the machinery of the "Neptune," see Scientific American Supplements, May 30th, 1914, page 348, and June 20th, 1914, page 392.

ward, thus opening communication between the space G and the atmosphere through the ports N in the governor spindle body.

In the center part of the diagrammatic sketch is shown the air relay cylinder, relay valve, and operating cylinder, which controls the opening and closing of the nozzles of the turbine according to the speed of rotation desired. Referring to this part of the illustration, and starting with the turbine at rest, the piston Y, which opens and closes the nozzle valves, is at the farthest end of its travel to the right, and all the turbine nozzles are closed. Now when air from the bridge control valve is admitted to the space P, to the left of the air operating cylinder, the piston Q will be forced to the right against the resistance of a small spring, thus carrying the relay plunger O with it. The movement of the latter establishes communication between the space R, supplied with high pressure oil, and the space X, to the right of the piston Y, and the space W, to the left of the piston Y, is brought into communication with the space T, and thereby with the oil return to the reservoir, which is open to atmosphere. Thus the piston Y will be forced to the left by the oil pressure and through a rack engaging with the gear cut in the periphery of the nozzle valve, will rotate the latter and open high pressure nozzles, thus admitting steam to the turbine. As there is nothing to resist the motion of the piston Y, nozzles in excess of those necessary to give the desired speed are opened instantaneously, and thus the turbine begins to speed up very rapidly. Now, however, as the turbine gains speed and the governor revolves, the governor spindle B is forced down and high pressure oil is admitted through the ports H and I and through the passage L to the space N to the right of the piston Q, thus tending to push it to the left against the air pressure in the space P. As the piston Q moves to the left, it carries the relay plunger O with it, and when the oil pressure in the space N balances the air pressure in the space P, or in other words, the space J' in the bridge control valve, the piston Q will take a fixed position, and the piston Y will take up a position such that the ports communicating with W and X are both closed, thus maintaining a constant speed of revolution.

Should the turbine tend to exceed the speed fixed by the air pressure in the space P, the piston Q would move to the left and bring the space X into communication with the space S, connected to the oil exhaust, and the space W would be brought into communication with the space R, supplied with high pressure oil. This would cause the piston Y to move to the right until sufficient nozzles had been shut off to reduce the speed, until the oil pressure in the space N was again brought into equilibrium with the air pressure in the space P.

The bridge operating stand which supports the bridge control valves is shown in our half-tone engraving, from which it will be seen that there is a rotary slide valve on top of the stand between the port and starboard control valves. This latter valve is not shown in the diagrammatic sketch previously described, and is not shown in detail because of the difficulty of showing the various ports in it. Its function, however, is to permit operating both turbines, either ahead or astern, by either the port or starboard control valve, or to cut out both the starboard and port control valves. In addition to these functions which this valve performs on the bridge control stand, the similar valve on the control stand in the engine room has a position for cutting out the bridge stand and other operating stands in other portions of the ship; thus when the control system on the bridge is connected, all control stands excepting that in the engine room, are made inactive, while if the stand in the engine room is being used, all other stands (including the one on the bridge) are disconnected. This arrangement avoids interference, permits rapid changes from one station to another, but always leaves the engine-room stand operative in case of an emergency.

Ordinarily, except when maneuvering, the bridge stand is always connected up so that both turbines are controlled by moving either the port or starboard control levers, which simplifies the operation and permits controlling both turbines if either the port or starboard operating valves should for any reason become temporarily disarranged.

In addition to the standard screw down valves on the ahead and astern turbines, each turbine is provided with a hand operating device, by means of which a nozzle valve can be moved by hand, if necessary or desirable.

This is accomplished by the lever h as shown in the diagrammatic sketch, Fig. 1. The lever is pivoted on the shaft j and has a lever engaging with the crosshead on the valve operating piston rod l. The latter lever is fitted with a latch so that it can be quickly connected or disconnected when not in use.

As previously pointed out, there may be a number of operating stations from which the turbines can be controlled when this is desirable, as for instance, there might be considerable advantage in the case of battleships in having the turbines controlled from the central station as well as from the bridge and starting platform.

After the officers have once become accustomed to using the bridge control, they will no longer use the engine room telegraph and will not feel as a man would, had he only the steering wheel of an automobile under his control and were he compelled to rely upon an engineer to control the speed and the direction of motion independently. As far as reliability is concerned, this has been absolutely proven by the experience on the "Neptune."

The only difference between the diagrammatic sketch and the actual valve gear is that in the latter the various parts have been placed one within the other in order to make the valve more compact.

In order that the officer on the bridge or navigator may be able to see that the turbines are operating as desired, and also to show that the control system is in operating condition, gages are provided which show the steam pressure in the boilers, the air pressure in the

pushes the plunger LA to the right, and the gage on the bridge is then connected to atmosphere through the ports K and H. When steam or oil under pressure is admitted at B, the plunger LA is forced to the left against the resistance of the spring, and the edge J of the plunger LA moves over the port G and admits high pressure air through the port K to the gage on the bridge, the pressure in the space to the left of the plunger LA increases until the pressure times the area of the left-hand portion of the plunger LA equals the pressure times the area on the right-hand portion of the plunger LA; thus if the diameter of the plunger L is twice the diameter A, the area of the large end of the plunger will be four times that of the small end, and the actual pressure maintained on the left-hand side of the plunger will be one fourth of that maintained on the right-hand side of the plunger; thus 200 pounds gage steam pressure would be indicated on the bridge by 50 pounds of air pressure. The oil pressures are transmitted to the bridge in the same way.

This relay device has been found very sensitive and accurate, and so far has never given any trouble in the installation on the "Neptune."

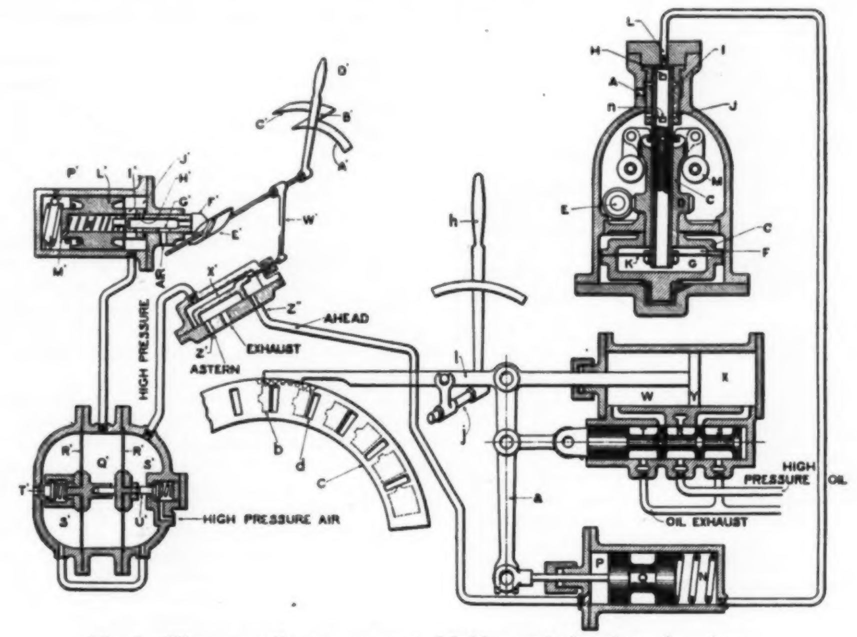


Fig. 1.—Diagrammatic arrangement of bridge control and nozzle valves.

control system, the air pressure in the pipe lines Z' Z'' as well as the pressure in the oil supply system, and the pressure of the oil under the pistons of the floating frame on the reduction gears.

As it would be frequently necessary to have the piping communicating from the engine room to the bridge in exposed places where it would be liable to freeze and because of the difficulty of allowing for the hydrostatic

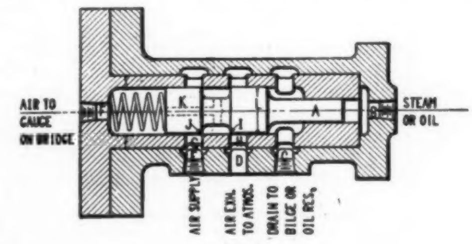


Fig. 2.

head in the pipe between the bridge and the engine room in the case of liquids, the steam and oil pressures are indicated on the bridge by means of compressed air and a small relay valve, such as illustrated in Fig. 2. As the steam pressure or oil pressure to be indicated on the bridge may exceed the air pressure available, the former are reduced in some ratio, such as 2 to 1 or 3 to 1, as required.

In Fig. 2 the orifice B is connected to the steam or oil line, and the pressure desired is indicated on the bridge by the air pressure in the pipe connection to F, which communicates with the gage on the bridge. The operating element of the relay consists of the plunger LA, having L and A the same diameter or A a smaller diameter than L for relaying oil or steam pressures. The plunger LA is fitted in a bushing, having ports G and H, port G communicating with the high pressure air supply and port H communicating with atmosphere. A drain C is also provided, which may either drain to the bilge or to the oil reservoir when oil pressure is being relayed.

Normally, when not being used, the small spring

There is a fixed pressure (for any given number of revolutions per minute of the turbine shaft) in the spaces Q' and S' S' as well as under the diaphragm K in the governor spindle and the space N to the right of the air operating cylinder. Consequently, instead of graduating the gage recording the air pressure in the space S' in pounds, this scale may conveniently be graduated to read revolutions per minute, so that those in charge on the bridge can see every instant exactly the number of revolutions which the propellers are making.

Another novel feature of the new control apparatus used on the U. S. "Neptune" is a set of speed recording instruments. As previously mentioned, for any given turbine speed there will be a definite oil pressure under the diaphragm K of the governor, and consequently this pressure can be used to indicate the speed of the turbine and propeller.

Pressure gages of the recording type may be used, showing the speed, direction of rotation, and period of operation of each turbine under any given conditions. These records furnish an accurate log which is indisputable in case of a controversy regarding the speed or manner in which the turbines were operated. These cards can be graduated to read revolutions or knots, as desired.

The Limit of Fatigue

PROFESSIONAL fatigue can be measured from the variations of the tracing or sketch of the movements of the heart. According to the experiments of M. Jules Amar explained by Prof. Dastre, it has been seen that as the power developed by the muscles increases, the form of the cardiograms is changed. Their summit becomes more and more pointed. The undulation on the right that is supplied by the contraction of the heart lowers progressively. After the contraction that drives back the blood an aspiration is produced, the value of which goes on increasing. In all physical work, carrying of burdens up staircases, fatiguing walking, running, work with the hammer, M. Amar has noticed curves that have an aspect identical to the physiological limit of fatigue.—*Chemical News.*

Transcatlantic Flight*

A Discussion of Possible Routes

By Lieut. H. Boykow, Imperial German Navy, Retired

By the latest endurance records in aviation the project of a transatlantic flight has been removed from the domain of vague and distant hopes, and placed among the immediate possibilities. Routes are available for the undertaking, which, as to distance and time, appear to be no more formidable than those over which aircraft have already flown. If it happens that on these very routes—i. e., the shortest available—serious obstacles present themselves, these obstacles are not found in the length or probable duration of the journey, but in circumstances of greater weight, to which due

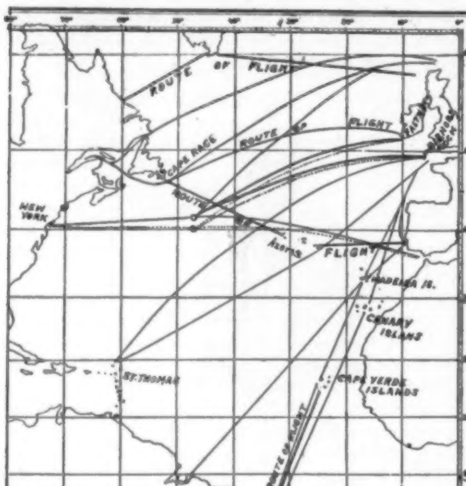


Chart 1.
International steam lanes, February 1st to August 31st.
———— English Channel—New York, westward.
.... English Channel—New York, eastward.

regard must be had if a route is to be selected in accordance with the idea that navigation is the art of bringing a vessel to her destination over the best course. The best course is not the shortest, nor the most convenient, but that which a scrupulous regard for all factors points out as offering the greatest security, combined with the minimum distance consistent with such security. Thus, for example, the fast transatlantic steamers, in the operation of which time is certainly an important consideration, do not follow the shortest routes, because the navigation of such routes is hazardous, and would compromise the principal purpose of the journey, which is to get the vessel safely to her objective point. In a much higher degree do these considerations apply to aircraft, which, although the most modern method of transportation, hardly vie in safety even with the primitive vessels of the ancient seafaring races of mankind.

Two points must be taken into consideration before all others, viz., the normal and probable weather conditions along the proposed route, and the probability of being able to get help in case of an accident. These two points should be given the greatest weight in determining the route. In view of the fact that aircraft are still limited in their range of action, and also of the possible need of intervals of rest on the part of the aeronauts, a third consideration is the possibility of breaking the journey at suitable points.

We shall first discuss the normal weather conditions along the various routes. Broadly speaking, four routes are possible:

1. The northern, or Greenland, route, from Labrador *via* the southern point of Greenland to Iceland or the Hebrides. This route, especially if *via* Iceland, is the shortest. The distances are: Labrador to Greenland, 980 kilometers (609 miles); Cape Farewell to Iceland, 1,200 kilometers (746 miles); Cape Farewell to the Hebrides, 2,200 kilometers (1,367 miles). It should, however, be stated at once that the Iceland route is practically ruled out by the fact that a stationary area of low barometric pressure lying south of Iceland is almost certain to give winds from an easterly quadrant.[1] At best this could only be regarded as a possible route for a journey from east to west, but there are other grounds, to be mentioned later, which exclude it from consideration.

2. The direct, or steamship, route from Newfoundland to Ireland. The distance to be covered by this route is 3,100 kilometers (1,926 miles), or still greater if the regular international steam lanes are followed. Aside from its length this route offers great advantages.

3. The Azores route, from Newfoundland *via* the Azores to the coast of Portugal. The distances are 2,000 kilometers (1,243 miles) for the first stage, and 1,300 kilometers (808 miles) for the second. These distances have already been surpassed by aeroplanes.

4. The equatorial route, from the Cape Verde Islands to Fernando da Noronha, on the Brazilian coast. The distance amounts to only 2,500 kilometers (1,553 miles), but in other respects this route appears less promising.

Except as to the equatorial route, which is available in winter or early spring, only the summer months need be considered as appropriate for a flight, viz., June, July, and August. We will now briefly examine the meteorological features of the North Atlantic, especially along the proposed routes. The first six charts accompanying the article serve further to elucidate this matter.

JUNE.

The maximum (of barometric pressure) at the Azores and the minimum south of Iceland begin to be more sharply defined, and consequently west winds become more frequent and stronger between latitudes 40 and 60 degrees north. Over the western half of the ocean the winds are prevailing southwesterly. Along the principal steamer routes (i. e., between latitude 40 and 50) June is one of the calmest and driest months of the year, with prevailingly fair weather. Barometric depressions are commoner at this season on land than on the ocean. Only along the storm track from Newfoundland to Iceland are they frequent; between Labrador and Greenland, in particular, secondary minima as low as 720 millimeters (28.35 inches) are likely to occur. The latter may also be said of the southeastern border of the Newfoundland Banks. In general, however, June and July are freer from storms than any other months of the year. On the southeastern border

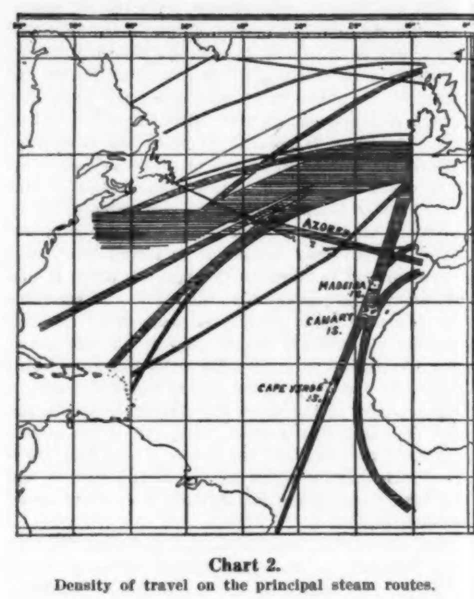


Chart 2.
Density of travel on the principal steam routes.

of the Banks, where at all seasons winds reaching force 8 on the Beaufort scale are frequent, not more than 6½ per cent of gales have been recorded in June, while in January, for example, the gales attain 38 per cent. The region of greatest storm frequency is generally identical with the region of the Gulf Stream.

The frequency of fog has somewhat increased. On the Banks and the American coast there are areas having over 200 hours of fog in the month. South of latitude 40, however, the ocean is practically fog-free.

The average weather conditions on the several routes in June are as follows: On the Greenland route, over the westerly half of the stretch between Labrador and Greenland the prevailing winds are north and east, with force 3 to 4, freshening and shifting to northwest as one proceeds toward Greenland; but revolving storms, moving generally from the southwest, are still comparatively common in this month. Just west of Greenland fresh westerly to southerly winds prevail, though small barometric depressions may also occur here, moving in a direction between southeast and northeast. Winds of force 4 to 6 predominate, and calms are rare.

* Translated for the Scientific American from *Zeitschrift für Flugtechnik und Motorluftschiffahrt.*

[1] This statement is hardly accurate. The Iceland "low" is strongly developed in winter, but diffuse and feeble in summer. Moreover, its position shifts rapidly, and it is by no means always central south of Iceland. At Vestmannö, the southernmost meteorological station in Iceland, the ratio of easterly to westerly winds is 35:22 for the year as a whole, and 34:25 for the three summer months; i. e., westerly winds are about two thirds as frequent as easterly. Calms, also, are frequent in all months.—Editor.

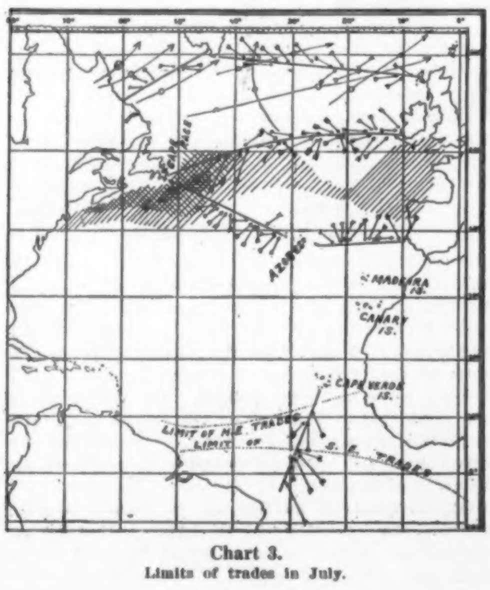


Chart 3.
Limits of trades in July.

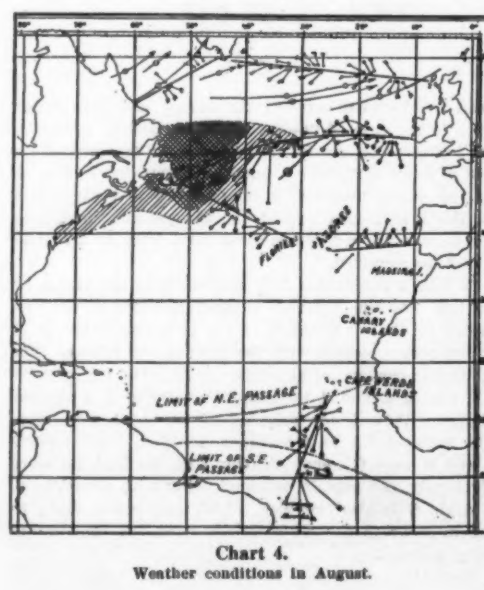


Chart 4.
Weather conditions in August.

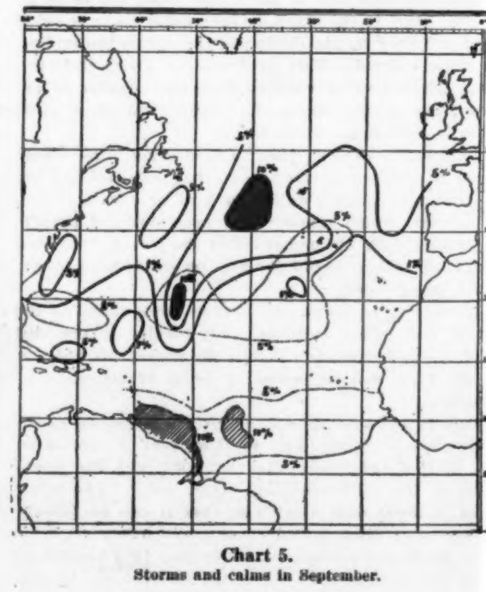


Chart 5.
Storms and calms in September.

On the Ireland, or steamship, route the main difficulty is the frequency of fog, amounting to from 10 to 25 per cent over almost the whole route. Over the western half of this route the winds are prevailingly from the two westerly quadrants, while farther east northeasterly and southeasterly winds may occur. These winds are generally fresh, with a force of from 4 to 5, but north of latitude 50 winds from south and south-southeast, attaining force 7, are rather frequent. Storm tracks are not found to any extent except on the southeastern edge of the Banks.

The most difficult part of the Azores route is at the beginning, as far east as about longitude 40, as this embraces the storm tracks and the fogs of the Newfoundland Banks; but it should be noted that this same portion of the route is the region of densest steamship traffic, as all the steamer routes to and from the chief American ports converge here. Thence on to the Azores the winds are moderate, not exceeding force 5, and from the westerly quadrants, while the weather is almost uninterruptedly fine. Between the Azores and the Portuguese coast moderate northerly breezes prevail.

The equatorial route begins in the zone of the northeast trades, which, however, extend only down to latitude 8 or 10 degrees north; then the belt of equatorial rains and calms must be crossed, until, somewhere of 5 degrees north latitude, the southeast trades are entered.

JULY.

The atmospheric conditions over the North Atlantic (see chart 6) assume their most definite summer character in July. Barometric depressions are rarely developed, and the weather is, therefore, prevailingly calm. The Azores "high" is now at its maximum and the non-periodic fluctuations of the barometer are small; accordingly the westerly winds between latitude 40 and 55 are steadier than in the other months, and rarely acquire much force. The northeast trades are feeblest at this season, and in this and the following month their southern limit lies farthest to the north. (See chart 3.) July is generally even freer from storms than June. Only southeast of the Banks are storms more frequent; while elsewhere over the ocean their frequency is everywhere less than 4 per cent. Hurricanes are very rare in July. Thus, of 216 hurricanes, only 29 have occurred in this month, or an average of one or two each year. (See chart 8.) Frequency of fog is at a maximum in July. On the Banks there are more than 300 hours of fog, on an average, during the month; while the limit of the region having more than 100 hours extends far to the eastward, but not farther south than the fortieth parallel.

The weather conditions on the Greenland route are characterized by the fact that the storm tracks, particularly those of the deeper depressions, have shifted farther to the north. On the Labrador side the winds blow mostly from the northwest, while nearer Greenland easterly winds, up to force 5, are of more frequent occurrence. Between the southern end of Greenland and the Hebrides light breezes from the westerly quadrants prevail, but cyclonic disturbances, moving chiefly from west to east, are still likely to be met with. On the direct (steamship) route the winds are also chiefly from westerly quadrants, and in midocean prevailingly from southwest. Cyclonic storms are rare on this route

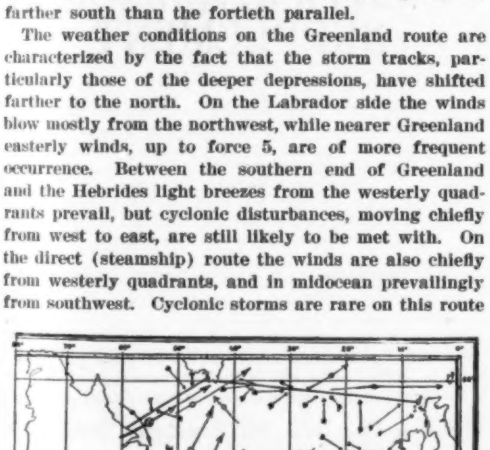


Chart 7.

Weather conditions in June. The arrows show the wind directions, the number of feathers on the shaft, the wind force on the Beaufort scale, and the length of the arrow, the frequency of occurrence (2.5 millimeters = 10 per cent). Arrows with circles are storm tracks (open circles indicate barometric minima of 730-740 millimeters; circles with dot, minima of 70-730 millimeters).

10—25% fog. 25—50% fog. 50% fog.

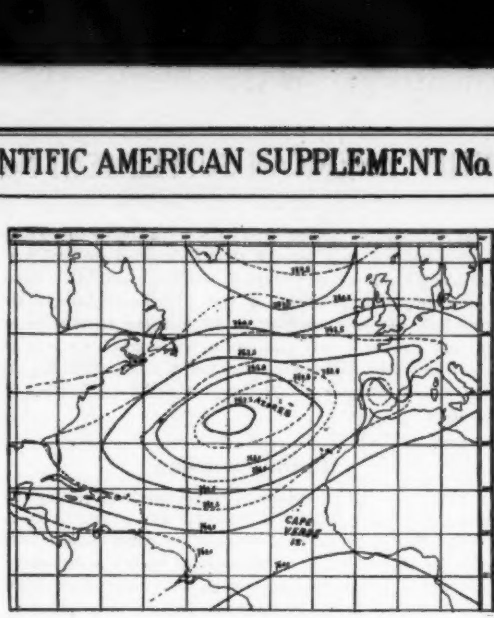


Chart 6.

------- Isobars in July. ———— Isobars in August.
(Pressure in millimeters.)

in July, and the weather is, therefore, usually fair. Between Newfoundland and the Azores much fog prevails on the first part of the route, with winds mostly from the southwest quadrant, but calms are frequent. On the equatorial route the northeast trades have retreated nearly to the Cape Verde Islands, while the southwest trades have shifted somewhat northward. Hence unfavorable winds may be expected over the greater part of the route.

AUGUST.

The barometric conditions are similar to those of July. The trade winds are farthest north this month. Storms are still rarer than in July, and only to the southeast of the Banks do they exceed 5 per cent. Secondary barometric depressions are frequent only north of latitude 55, but the winds between latitude 50 and latitude 55 are often very fresh, ranging up to force 8.

On the other hand, August is a month of frequent hurricanes. About 21 per cent of West Indian hurricanes occur in this month. Even in the neighborhood of the Cape Verde Islands these storms are likely to occur. Fogs are somewhat less frequent than in the previous month, but the fog area extends considerably farther north. On the Greenland route the winds are mostly southeasterly or northwesterly between Greenland and Labrador, while between Greenland and the Hebrides they are almost exclusively from the two westerly quadrants. (See chart 4.)

On the direct route, southwesterly and southerly winds of great steadiness prevail on the American side, while on the European side the winds are fresh and chiefly from the two westerly quadrants, though southeasterly winds are not rare. The winds and weather along the Azores route are similar to those of July. The equatorial route is unfavorable in August on account of the prevalence of contrary winds and the frequency of hurricanes.[2]

SEPTEMBER.

The quiet conditions characteristic of summer still generally prevail in September, and this month is further marked by the frequent occurrence of easterly winds between longitude 10 and 30 west on the New York route. Storms, however, are considerably more frequent than in the previous month, especially in midocean. Moreover, September and October are the months of most frequent hurricanes. Of West India hurricanes 32 per cent occur in September. The frequency of fog has greatly diminished. In general, September does not offer as favorable conditions as August on any route. (See chart 5.)

October and November develop the definitely unfavorable conditions which reach a maximum in December, the month of coldest, stormiest, and rainiest weather at sea, with a storm-frequency amounting to 30 per cent or more. The depth of the barometric depressions reaches 710 millimeters (27.95 inches) or under. The northerly routes are impracticable at this season, but conditions on the equatorial route are somewhat more favorable, as the northeast trades extend far south and on the northern border of the southeast trades about 10 per cent of calms may be expected.

Thus, for the three northern routes only the three summer months, June, July, and August, need be taken into consideration, while for the equatorial route the winter and early spring months are the most favorable. Which of these routes is the most promising from a meteorological standpoint? The general wind conditions on the Greenland route, for example in July, would seem to be not unfavorable, but against the selection of this route may be urged the generally low barometric pressure and the comparative frequency of storm tracks. Along the Ireland route one may generally count on fine weather and favorable winds in July. The Azores route has a dangerous stretch on the southeast border of the Newfoundland Banks, but is characterized elsewhere by the great stationary Azores "high," giving generally fair weather, but winds mostly at right angles to the direction of flight. The character of the equatorial route depends upon the development of the southeast trades at their northerly border.

Hence, the most favorable routes in a meteorologcal sense are the Ireland route and the Azores route, in July. As to the distance to be covered, the most favorable, except the Iceland route, is the Azores route, on which only 2,000 kilometers (1,243 miles) must be made in one flight, a distance which can be covered by our modern machines. Next comes the Greenland-Hebrides route, with a lap of 2,200 kilometers (1,367 miles). The greatest distance to be made in one flight on any route is 3,100 kilometers (1,926 miles) on the Ireland route, and this would be increased to about 3,500 kilometers (2,175 miles) if the aviator kept close to the international steamship routes.

The third point to be considered is the density of traffic over the various oceanic regions in question. As will be seen from charts 1 and 2, the Greenland routes are altogether outside the area of steamship travel. The main stream of travel extends from Bishop Rock or Fastnet along a great circle to longitude 47 west and latitude 41½ north on the westbound routes, while the eastbound routes lie about a degree, or 111 kilometers (69 miles) farther south. Hence, in order to take advantage of this main artery of travel, when flying over the Ireland route, a détour is necessary. This détour is to be recommended under all circumstances, for if anything should happen to the machine over the comparatively little traveled northern waters the aeronauts would in all probability be lost, whereas on the great steamship track the prospects of a rescue would be good, provided the wrecked aviators could attract attention to their plight, if not by wireless telegraphy, perhaps by smoke signals or the like. If apprised in advance of the flight, vessels would keep a sharp lookout for a case of this kind. The conditions are very favorable on the Azores route, which crosses the most important vessel tracks between Europe and North America and between the English Channel and Central America. Just at the most dangerous part of this route would be met the big fishing fleet on the Banks, which would greatly enhance the safety of the journey. The eastern part of this route, between the Azores and Portugal, is also much frequented by vessels, as it intersects the steamship routes to South America, Madeira, Teneriffe, and West and South Africa. The steamship routes from Gibraltar to North America are almost identical with the route of flight. The equatorial route runs along the steamship track to Brazil, but otherwise this portion of the ocean is little traveled.

Hence from this point of view the Azores route and the Ireland steamship route stand at the head. A physiological factor favoring the Azores route is the relatively warm and pleasant climate.

As a last important point, the purely nautical conditions of the various routes must be considered. These include (1) deviation from the course and its results, (2) the chances of a good landfall, and (3) the possibility of verifying one's course. On the northernmost route the conditions are not promising, as in case of getting off his course or meeting with an accident the aviator would be helpless, while the coast is of no service, on account of the mostly onshore winds, and offers little shelter. There are no passing ships to

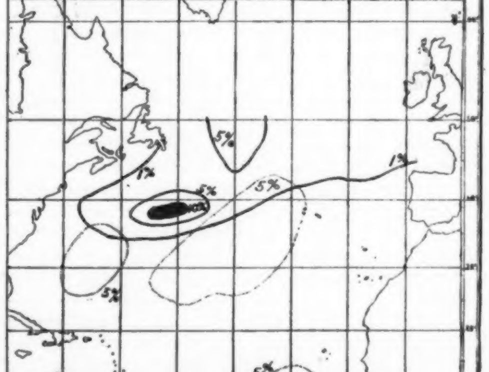


Chart 8.

Storms and calms in July. ———— Line of equal frequency of storms. .... Line of equal frequency of calms.

[2] True hurricanes—i. e., tropical cyclones—are probably rare on this route.—Editor.

enable the aviator to verify his course. More favorable conditions obtain on the two middle routes, especially on the Ireland steamship route, on which both the landfall and the checking of the course offer no difficulties. On the Azores route the landfall at the Azores offers considerable difficulty. To be sure these islands stretch over about 600 kilometers (373 miles) in longitude, but they are much less extensive in latitude. A considerable deviation from the course might, therefore, be fatal, as the next land on the route in this direction would be the Madeira, Canary, or Cape Verde Islands, or the European or African continents. However, this obstacle is not decisive if watchful navigation be maintained, with the fair weather prevailing almost constantly in this region. In case of necessity an observation for position would need to be made, and this can be done from an aeroplane within an error of 50 miles or so.

The following table summarizes the features of the various routes, which are arranged in order of merit with respect to the factors specified:

Distance.	Meteorological.	Density of travel.	Navigation.	Physiological (as to climate and duration of flight).
1. Iceland	Ireland and Azores	Ireland and Azores	Ireland	Azores
2. Azores	....	....	Azores	Equatorial
3. Greenland-Hebrides	....	....	Equatorial	Ireland
4. Equatorial	....	....	....	....
5. Ireland	....	....	....	....

It is evident from the above that by far the best routes are the Ireland route and the Azores route, and with such aeroplanes as we have to-day the Azores route appears to be entitled to first consideration. The greatest distance to be flown is about 1,200 miles; the weather conditions are, at the worst, not unfavorable; and it is possible to break the journey with a day of rest. Given, however, aeroplanes capable of covering the great distance of the Ireland route, the latter would, as a non-stop flight, possess a greater sporting interest.

Hence, for the aeroplanes of the present the Azores route; for the great aircraft of the future, the Ireland route.

A few words may now be said regarding the nautical equipment of an aeroplane for an ocean flight. The first principle to be observed under this head is not to burden oneself too heavily with instruments, etc. The proper instrumental equipment is about as follows:

a. With a passenger: 1. A reliable compass, suitable for aeronautical use. Such compasses are obtainable, but cost a little more than ordinary instruments. The aeronaut should beware of instruments which have not been tested and found to be in good working order. The money paid for a good compass will be well expended. 2. A normal observing sextant for horizon observations. Leveling instruments are hardly necessary in this particular case, and an aeroplane hardly offers a suitable platform for their use. 3. A good timepiece set to Greenwich time. 4. If desired, a device for summer line determinations, such as the Orion or Brill instrument.

b. Without passenger. In this case astronomical observations are impossible, and the corresponding apparatus may, therefore be omitted. A compass is, of course, indispensable.

In both cases an hypsometer will, naturally, be needed. As to a chart, the general map of the North Atlantic will suffice, and from this may be cut a strip corresponding to the selected route, which may be mounted on one or two rollers. In connection with this it will be advisable to take a parallel ruler.

We have already spoken of the possibility of getting position by signal from passing ships. It would be well for the aviator, some time before beginning his flight, to request all the great steamship companies to instruct their captains to hoist the international signal for their position (probably to whole degrees) as soon as they come in sight of an aeroplane on the high seas, and without waiting for a request from the aviator. A pilot having, alongside of his chart, a table of such signals can then ascertain immediately his own position, and adjust his course accordingly. The author feels confident that such a request would be cheerfully compiled with by the steamship companies, and thus, for the aviator flying alone over one of the two middle routes, a great difficulty would be disposed of.

One more point remains to be mentioned. We have purposely refrained from considering the possibility of a water-landing or a renewal of the fuel-supply on the high seas, because, in the author's opinion, such a procedure would be equivalent to abandoning the flight. The reason for this opinion is the unseaworthy character of hydro-aeroplanes. Why these craft are not yet staunch enough for the high seas need not be discussed here; we will only remark that there is a preliminary problem to be solved before it will be possible to solve completely the problem of the hydro-aeroplane. All this has, however, nothing to do with the transatlantic flight. Provided only the motor holds good the feat is possible without breaking the journey by alighting on the water, and nowadays when a thing is possible it is done.

Musical Sensation

VERY curious experiments, especially interesting to musicians, have just been made by Dr. Marage. In a recent study, he had shown that for each vowel there exists a note on which a minimum of energy is necessary to make it heard; that is, indeed, the origin of the telephonic "Hello." Dr. Marage, in a paper presented before the Academy of Sciences by Prof. d'Arsonval, studies the sensibility of the ear for certain musical sounds. The question was to know the impressions experienced by an audience composed of musicians, savants, literary men, and society people, while listening to the same pieces of music of the sixteenth and seventeenth centuries, performed successively on the piano and on instruments of the period: clavecin, clavichord, lute and viol. To realize this experiment, the three hundred pupils who follow the classes at the Sorbonne of the physiology of speech and singing have been divided into two series. The pupils were to note their physiological and musical impressions. Out of an audience of 300, only 142 copies were given in; that is to say, that over 50 per cent of the pupils had no impressions or did not wish to write them down. And yet the copies were anonymous. The other half, however, on the contrary, experienced very diverse sensations. The pupils who gave in their copies were divided into 51 professional musicians or singers; 25 cultivated persons—that is to say, with a good knowledge of music and studying it from a taste for the same; 34 with no musical knowledge; 13 scientific persons, professors, pupils of the Polytechnic School, of the Central School of Civil Engineers, or of the Sorbonne; and 19 literary professors or pupils. The copies, judged from the point of view of the analysis of the sensations, have given the following results: The cultivated come out at the top of the list with 77 per cent of good copies; professors of singing and music come next with 62 per cent. The scientific pupils are greatly superior to the literary; 47 per cent of the first against 35 per cent of the second gave in excellent copies. The literary people make long descriptions, interesting and agreeable to read, but it is often difficult to discover what are the sensations they experience. The scientific, on the contrary, have clear ideas expressed in a few lines. Concerning the physiological impressions, it is to be remarked that almost all the audience is at first disagreeably impressioned by the thin and metallic sounds of the clavecin, then the ear gradually gets used to these chords, new to it, and then it finds in them certain qualities. The grave sounds of the viols are immediately agreeable to the audience. A curious phenomenon of suggestion has also been observed by M. Marage. After a first performance, it was decided to change the piano. The instrument was new, and it had been thought that the sounds it gave forth were not very harmonious. Twenty musicians had expressed the desire to be present at the second series, at which the same programme was to be performed. They all noted down that the new piano was very superior to the first one. Now, for some reason unknown to M. Marage, the instrument had not been changed, and was the same at both series. To sum up, Dr. Marage wonders if musical critics are not often influenced by the special dispositions of their auditive nerves. The particular action of vibrations on each nervous system, the habit of hearing certain sounds, and, lastly, the previous education, must deprive the artistic criticism of the value possessed by the scientific criticism.—*Chemical News*.

Problems of Stability in Aeroplanes

CONTRARY to the general opinion, the view is not held by the most competent authorities that perfect automatic stability is a desirable attribute. A certain degree of inherent stability, especially in the longitudinal sense, is already possessed by most modern aeroplanes, and would at the present time appear to be adequate. With lateral stability the case is different, for until the present time this has been obtained only in a minor and insufficient degree, and in machines of certain types it is precarious to the point of depending for its maintenance wholly on the intervention of the pilot. At first sight it might well seem as if no aeroplane could be too stable. Since longitudinal stability is largely a question of maintaining flying speed, the view is correct enough in that limited sense, provided that stability in this case does not preclude speed variation. On the other hand, too great a degree of stability in every other respect must necessarily render an aeroplane insensitive to control, and interfere with easy steering. As a case in point we may take a well-known aeroplane possessing as high a degree of automatic stability as any hitherto designed. In calm weather this machine behaves admirably, requiring practically no controlling from the pilot; but in a gusty wind it behaves in such an erratic manner as to render it a matter of the greatest difficulty to steer an accurate course.

A well designed aeroplane, on being struck by a gust and being tilted up on one wing, recovers automatically, provided the gust be not too violent, and the first oscillation will be immediately followed by one in the opposite direction until a level keel is again attained. Naturally, it is desirable that these oscillations should be damped out as quickly as possible, and should in any event be prevented from attaining too much amplitude. Every consideration points to the conclusion that lateral stability should never be unduly exaggerated.

But there is a final factor to be taken into account. Perfect automatic stability loses its disadvantages for an aeroplane flying in comparatively calm air, and in those conditions even becomes a positive advantage, since it relieves the pilot of his controlling duties and leaves him free to devote himself to others, such as observation. The best solution, therefore, would appear to be to devise some form of automatic stabilizer capable of being set in action or cut off at any moment by the pilot, who would thereby have at his disposal the dual advantage of automatic stability in calm air and of perfect controllability under all conditions.

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